SCIENCE ABSTRACTS

SECTION A

PHYSICS.

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ERRATA.

Section A.—PHYSICS.

Abstract No. 2106, line 2; *for* Gambarzeff, *read* Gamburzeff.
Abstract No. 2265, line 2; *for* Block, *read* Bloch.
Abstract No. 2541, line 1; *for* Na, *read* La.
Abstract No. 2628, line 2; *for* Margenaw, *read* Margenau.

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST, 1930.

GENERAL PHYSICS.

2707. Theory of Mechanical Indicators. N. Kryloff and N. Bogoliuboff. *J. de Physique et le Radium*, 1. *pp.* 77–92, *March*, 1930.

Watt's indicator gives a graphical representation of the integral of a differential equation of the type $md^2y/dt^2 + \lambda dy/dt + cy = f(t)$. The author seeks an estimate of the form of $f(t)$. The case of the oscillograph was specially in view, but the generalised theory holds also for seismographs, vibrographs, etc. Convenient constants are required such that the theory of simple (Cornu) or integral (Blondel) synchronisation may be satisfied. In the theory these two forms of synchronisation are considered and the mean square error for the latter obtained. Among different methods one emphasised is that of the displacement of the diagram, and the generalised method for this is developed. The mean square error is taken in the case where the simple synchronisation is most perfect. The constants are then found for the case of integral synchronisation, such that the errors shall be as small as possible. In a table is then set out the magnitude of the error in the most convenient form for practical use and relating to the two formulæ for rectification of the diagram. Finally, consideration is given to the value of the point error by these methods. R. S. R.

2708. Theory of the Regulating Fork. J. Haag. *Comptes Rendus*, 190. *pp.* 576–578, *March* 3, 1930.

Examines the theory of the regulating fork, assuming that the balance spring is supported by the pin, through which it can slide with a certain coefficient of friction f. The method employed is an application of the general method previously developed [see Abstract 18 (1930)], the reaction of the pin, the sliding, the disturbing couple acting on the pendulum, and the variation of movement of the clock being calculated. A coefficient of limiting friction F, which plays an important part in the theory, has to be introduced, and this quantity can be either positive or negative. R. C. F.

2709. Absolute Micro-Manometer Depending on Electrostatic Compensation. P. Bricout. *Comptes Rendus*, 190. *pp.* 733–735, *March* 24, 1930.

The principle of the instrument is that a light metal plate placed between two parallel plates maintained at temperatures T_1, T_2 in a gas at pressure p and temperature T is subjected to a force per cm.^{2} of $p(T_2^{\frac{1}{2}} - T_1^{\frac{1}{2}})/2T^{\frac{1}{2}}$. This force is balanced electrostatically. A detailed description with figure is given. The instrument can be made so as to be sensitive to pressures as low as 10^{-2} to 10^{-2} baryes. C. A. S.

2710. Film Thicknesses on Surfaces. L. I. Weber and G. Lewin. *Kolloid Zeits.* 50. *pp.* 197-199, *March,* 1930.

If capillary tubes are soaked in substances exhibiting active or inactive surface energy, and after a little time these substances are removed, it is possible to obtain by stalagmometrical or titration measurements, values for the thickness of the films remaining on the capillary walls. The order of magnitude is on the average 10^{-4} cm. Similar thicknesses have been obtained by Bartoch by the adsorption of oleic acid by ores, by Trillet's investigations by means of Röntgen rays of lubricating films on metal surfaces, by Hardy on similar films between a plate and a cylinder using a micrometer, and by Tausz and Dreifuss for films between metal plates by electrical measurements. J. K.

2711. Condensation Pumps. K. C. D. Hickman and C. R. Sanford. *Rev. Sci. Instruments,* 1. *pp.* 140-163, *March,* 1930. *Kodak Research Lab. Comm.* No. 418.

The most recent high-vacuum pumps are actuated by a vapour stream. Various types are described and illustrated; but in all the pumps operated by mercury vapour the condensed mercury must return by the same path as the vapour and in opposition to its flow, which is disadvantageous. This drawback was obviated by Langmuir in his inverted construction, and some other inventions are described to overcome the same difficulty. Certain other materials can be used in the place of mercury, such as certain high-boiling fractions separated during the vacuum sublimation of petroleum residues, but they have peculiarities of their own. The authors have investigated the production of volatiles on boiling, and the relative stability of a few of them is shown in a chart. All petroleum oils show a tendency, increasing with a rise in boiling point, to decompose, but the esters of phthalic acid were so greatly superior in efficiency of pumping and in stability that they alone were studied in the later stages of the investigation. Various designs of jets for pumps are considered, and the question of size is important. The method of cooling is gone into, and certain dimensions for the pumps are recommended. The performance of a pump is given, and the results appear in a series of graphs. The conclusions of the authors are summarised at the end of the paper. [See also following Abstract.] T. C. H.

2712. Purification, Properties, and Uses of Certain High-Boiling Organic Liquids. K. C. D. Hickman and C. R. Sanford. *J. Phys. Chem.* 34. *pp.* 637-653, *March,* 1930.

The relative merits of mercury and stable organic liquids of high boiling point in certain physical operations are discussed. Consideration of the laws governing the flow of gases leads to a design of apparatus for distillation at very low pressures, in which the distance between the distilling and receiving surfaces is as small as possible and the diameter of the vapour passage large. With this apparatus liquids of low vapour pressure are obtained in a pure state, and the relation between their vapour pressure and temperature is determined. Of the liquids investigated, two, di-butyl phthalate and butyl benzyl phthalate, are found to be suitable for operating condensation pumps. Compared with mercury and a selected fraction from vacuum pump oil, the vapour pressures in mm. mercury are: mercury, $2{\cdot}3 \times 10^{-3}$ at 25° C., $2{\cdot}4 \times 10^{-4}$ at 0° C.; butyl phthalate, $7{\cdot}8 \times 10^{-5}$ at 25° C., $3{\cdot}5 \times 10^{-6}$ at 0°C.; butyl benzyl phthalate, $6{\cdot}2 \times 10^{-6}$ at 25° C., $2{\cdot}6 \times 10^{-7}$ at 0° C.; heavy hydrocarbon, $2{\cdot}9$–$4{\cdot}0 \times 10^{-6}$ at

25° C., $1 \cdot 2$–$2 \cdot 1 \times 10^{-7}$ at 0° C. In the condensation pump butyl phthalate attains its maximum efficiency a few minutes after commencement of boiling, butyl benzyl phthalate requires boiling for some hours initially, but works well in a few minutes in subsequent operations, while the pump oil requires two days' initial boiling and chars on continued use. The adhesion of mercury to glass tubes under ordinary conditions is due to the presence of a sheath of oxide on the meniscus and down the column of mercury. A supernatant layer of organic liquid overcomes this adhesion by assisting the crumpling of the film, by insulating the film from the glass or by dissolving the film. Organic liquids suitable for these purposes are described. A. J. M.

2713. Surface Energy of Solids. Part I. Surface Energy of Barium Sulphate. B. Bružs. *J. Phys. Chem.* 39. *pp.* 621–626, *March*, 1930.

Methods of determination of the surface tension of solids are first discussed, following which the calorimetric method is applied to the determination of the surface tension of $BaSO_4$, the order of magnitude of the theoretical value of $\sigma = 310$ ergs/cm.^{2} being confirmed. Surface energies as large as 2200 cal./mol. have been determined. The existence of a region of maximum grain size for certain concentrations of the reagents in a metathesis reaction has been established calorimetrically. H. H. Ho.

2714. Influence of Molecular Forces of Attraction on the Internal Friction of Gaseous Mixtures. G. Jung and H. Schmick. *Zeits. f. phys. Chem.* 7. *Abt. B.* 2. *pp.* 130–147, *March*, 1930.

The viscosity of a binary gaseous mixture is determined by the persistence factor—dependent on the mass ratio—and the mean free path. With mixtures of gases having molecules of similar masses, the influence of the persistence is small in comparison with that of the molecular forces of attraction, which also modify the mean free path. Since the potential energy on impact of two molecules of different electrical symmetry lies considerably below the geometric mean of the potential energies characteristic of the two kinds of gas, the mean free path and, hence, the viscosity of a gaseous mixture are greater than those calculated by the linear law of mixtures. The results of measurements of the viscosities of mixtures of the dipole : non-dipole and non-dipole : non-dipole types confirm this conclusion. Determinations of the viscosity of the binary mixtures, HCl-air, HCl-CO_2, NH_3-air, CO_2-air, H_2S-air, CH_4-NH_3 and CO_2-SO_2 are described. T. H. P.

2715. Viscosity of Vapours of Organic Compounds. Part II. T. Titani. *Chem. Soc. Japan, Bull.* 5. *pp.* 98–108, *March*, 1930. *In English.*

The viscosities of a number of vapours of organic compounds were determined by a capillary viscometer devised by the author. The materials used for the determinations were carefully purified before use. The substances included: ethane, propane, iso-propane, normal butane, ethylene, propylene, iso-amylene, acetylene, allylene, trimethylene, methyl ether, methyl chloride, methyl bromide and sulphur dioxide. The measurements were carried out over a range of temperature from 20° to 120° C. The results showed that Sutherland's formula was applicable to all gases, and a good agreement was obtained between the observed and calculated values. [See also Abstract 1709 (1930).] F. J. B.

2716. Damping of a Pendulum by Viscous Media. F. E. Hoare. *Phil. Mag.* 9. *pp.* 502–505, *March*, 1930.

In continuation of previous work [see Abstract 1712 (1930)] the values of two " constants," K_1 and K_2, occurring in the equation for the log dec. of a pendulum swinging in a viscous medium are investigated by experiments carried out in water and aniline. Values of viscosity derived from results obtained with various amplitudes of swing show systematic variations, and three possible causes of these variations are suggested. J. S. G. T.

2717. Laminar Boundary-Layer along a Spherical Boundary in a Uniform Flow of Water. A. Miyadzu. *Tohoku Univ., Technol. Reports*, 9. *pp.* 41–56, 1930. *In English.*

The equations of motion and of continuity for the laminar boundary-layer along a spherical boundary, in a uniform flow of an incompressible fluid of small viscosity, have been derived from Navier-Stokes' fundamental equations by transforming them to polar coordinates. The thickness of " G " along the spherical boundary and the point of separation (Ablösungspunkt) where the laminar flow deviates from this wall surface have been determined by making use of the above equations with a numerical example. The case of the radially outward flow on a plane boundary has also been examined, and the flow between two parallel planes considered. H. H. Ho.

2718. Vortex System in the Wake of a Cylinder in a Fluid. H. Levy and S. G. Hooker. *Phil. Mag.* 9. *pp.* 489–502, *March*, 1930.

The theoretical results obtained by Glauert and others on the assumption that the Kărmăn arrangement of vortices is maintained stably and unimpaired in a flowing channel are shown not to possess a valid physical basis. J. S. G. T.

2719. Equations of an Elastic Medium in a Form Independent of the Coordinate System. A. Tonolo. *Accad. Lincei, Atti*, 11. *pp.* 247–250, *Feb.* 2, 1930.

The equations of Lamé are put into tensor form, so as to apply to all systems of curvilinear or other coordinates (not necessarily orthogonal). J. H. A.

2720. Dynamical Method for Determining Relation between Elastic Constants of Rods and Temperature. E. Goens. *Ann. d. Physik*, 4. 6. *pp.* 733–777, *March* 26, 1930.

The method was designed for testing monocrystals, in the form of small rods, at temperatures ranging from + 180° C down to − 195° C. The rod was suspended vertically by a long thin bifilar suspension, and was loaded at the ends by two horizontal, **H**-shaped masses, the outer limbs of the upper **H** being formed of two small bar magnets; one pole of each of these magnets was surrounded by a coil of wire, and e.m.f.'s were induced in these when the rod under test was made to vibrate, either transversely or in torsion, since the magnets then moved in and out of the coils. These were suitably connected through an amplifying valve to a telephone, and by observing the pitch of the note produced the time of vibration of the monocrystal rod could be determined. The apparatus was cooled when required with liquid hydrogen. Preliminary experiments with polycrystalline Al and Fe are recorded. These show considerable differences from the values obtained by Schaefer, while the value of the temperature coefficient of the modulus of torsion agrees satisfactorily with that of Guye and Fréedericksz. With iron the differences are considerably smaller. H. N. A.

2721. Vibrations Damped by Solid Friction. S. Thomas. *Phil. Mag.* 9. *pp.* 329–345, *March*, 1930.

Theoretical and experimental treatment of the conditions when two bodies between which friction may exist have on the average a relative velocity, as for example a compound pendulum swinging on a continuously rotating axle. W. H. GE.

2722. Elasticity of Pintsch Crystals of Tungsten. S. J. Wright. *Roy. Soc., Proc.* 126. *pp.* 613–629, *March* 30, 1930.

Some difficulty was experienced owing to the fact that, in the majority of the wires available, two crystals of nearly the same orientation existed side by side often along the length of the wire. Five wires, each consisting of one crystal over a sufficient portion of its length, all with different orientations, were found and experimented with. For bending tests the wire was clamped in a horizontal position between the centres of two equal horizontal, parallel inertia bars, which were suspended by a bifilar arrangement of fine silk threads. Vibrations were set up in the system, which bent the wire first in one direction and then in the other in a horizontal plane; these were observed telescopically, and the time of vibration determined. In the torsion tests the wire was suspended vertically, one of the inertia bars being clamped in a horizontal position to its lower end. It was found that the modulus of rigidity for crystals of any orientation does not vary by more than 1 part in 200; tungsten crystals may be regarded as truly isotropic. The value of Young's modulus $= 3 \cdot 886 \times 10^{12}$ dynes/cm.^{2}, the modulus of rigidity $= 1 \cdot 514 \times 10^{12}$ dynes/cm.^{2}, Poisson's ratio $= 0 \cdot 284$. The values of the S constants and those of Bridgman are given in the following table in dyne/cm. units:

	Wright.	Bridgman.
S_{11}	$2 \cdot 573 \times 10^{-13}$	$2 \cdot 534 \times 10^{-13}$
S_{12}	$- 0 \cdot 729 \times 10^{-13}$	$- 0 \cdot 726 \times 10^{-13}$
S_{44}	$6 \cdot 55 \times 10^{-13}$	$6 \cdot 55 \times 10^{-13}$

H. N. A.

2723. Physical Problems with Discontinuous Initial Conditions. H. Bateman. *Nat. Acad. Sci., Proc.* 16. *pp.* 205–211, *March*, 1930.

A mathematical paper on the solutions of the principal partial differential equations of mathematical physics when the functions involved in the initial conditions are discontinuous. G. C. McV.

2724. St. Venant Problem for Pure Torsion. H. Villat and M. Roy. *Comptes Rendus*, 190. *pp.* 702–705, *March* 24, 1930.

The author shows that the distribution of tensions in a beam given by the theoretical problem of St. Venant leads in the case of very thin beams to results which, while of theoretical interest, are of little practical importance. This is illustrated in results obtained for a hollow, very thin circular tube split along its axis, and for a flat, thin beam of rectangular section. [See also following Abstract.] R. S. R.

2725. St. Venant Problem for a Cylinder. Mesnager. *Comptes Rendus*, 190. *pp.* 776–777, *March* 31, 1930.

The author criticises the statements made by Villat and Roy [see pre-

ceding Abstract], and considers that when the forces do not exceed the elastic limits the rigorous solution holds. He gives a practical illustration of each of the two cases quoted by Villat and Roy. R. S. R.

2726. Cohesion in Monovalent Metals. J. C. Slater. *Phys. Rev.* 35. *pp.* 509–529, *March* 1, 1930.

The theory of metallic structure, of Sommerfeld, Heisenberg and Bloch, is carried far enough to explain cohesive forces, and calculations are made for atoms with one valency electron, particularly metallic sodium. The numerical results, though rough, are in qualitative agreement with experiment. The forces in general are of the same nature as those met in ordinary homopolar binding, discussed by Heitler and London, except that the purely electrostatic force from penetration of one atom by another is relatively more important, the valency effect from the exchange of electrons relatively less important, than in diatomic molecules. As a preliminary to the calculation, the relations of the methods of Heisenberg and of Bloch are discussed, and it is shown that they are essentially equivalent in their results when properly handled. Remarks are made both about conductivity and ferromagnetism. In connection with conduction, it is shown that a definite meaning can be given to free electrons, that they are necessary to conduction, and that a method can be set up for computing their number, which is rather small compared with the number of atoms. Ferromagnetism is discussed in connection with a recent paper by Bloch. It is shown that a metal like an alkali cannot be ferromagnetic, for atoms at such a distance that the interatomic forces keep the metal in equilibrium are too close to be magnetic. For ferromagnetism, rather, it seems necessary to have one group of electrons responsible for cohesion, and another group, of smaller orbit and, therefore, relatively farther apart, producing the magnetism; a situation actually found only in the iron group and the similar groups. AUTHOR.

2727. Mosaic Structure of Bismuth Single Crystals. A. Goetz. *Nat. Acad. Sci., Proc.* 16. *pp.* 99–105, *Feb.*, 1930.

An experimental study of the etch figures of Bi single crystals to detect a regularity in the mosaic structure of a crystal as postulated theoretically by Zwicky. The smallest size of triangular etch pattern over an undisturbed area on the main cleavage plane was the same within experimental error and was 5 or 6 times the smallest distance resolvable by the microscope. The larger triangles were whole-number multiples of the smallest unit, which unit is independent of the perfection, purity and individuality of the Bi crystal. When a deformation causes a twinning the thickness of the smallest twin lamella is approximately the size of one mosaic block. The picture formed of a single crystal is one of blocks of an ideal crystal surrounded on all sides by a very thin hull of higher density. It is possible that the " block " is the smallest unit of a crystal above the fundamental lattice unit cell. Excellent microphotographs accompany the paper. [See also Abstract 2338 (1930).] W. H. GE.

2728. Possible Influence of Mosaic Structure of Crystals on the Determination of Avogadro's Number. F. Zwicky. *Nat. Acad. Sci., Proc.* 16. *pp.* 211–215, *March*, 1930.

The discrepancy between the values of the wave-lengths of X-rays determined, on the one hand, by a knowledge of Avogadro's number and the lattice constant of the crystal used, and, on the other, by direct measure-

ment, must necessarily exist owing to the error introduced into the calculation of the lattice constant by neglecting the mosaic structure of the crystal. An estimate of the amount of this error is given, and further experiments are indicated which would test this explanation of the differences in the wave-lengths obtained by the two methods. G. C. McV.

2729. Stability of Metallic Crystal Lattices. R. H. Canfield. *Phys. Rev.* 35. *pp.* 530–542, *March* 1, 1930.

The first sections of this paper are a partial repetition and amplification of Born's theory of homopolar crystal lattices, without, however, making any assumption about the law of force between atoms other than that the force is central and that diatomic molecules are possible. The mathematical work is supplemented with graphical illustrations. If the lattice is in equilibrium as regards (*a*) displacement of one atom, (*b*) unidirectional extension of the entire lattice, and (*c*) simple shear of the entire lattice, it is shown that each of these postulates leads to a restrictive condition on the symmetry and pattern of the possible lattices, thus accounting for the high symmetry actually observed. Finally, if the equilibria *a*, *b*, *c*, are stable, there are three series of terms in W″, corresponding to elastic constants, which must be positive. Making use of these series, it is shown that the lattice is likewise in equilibrium against motion of one portion *en bloc* relative to another portion, and hence that "mosaic" crystals cannot be configurations of minimum potential energy. Author.

2730. Structure of Solid Carbon-Monoxide. L. Vegard. *Zeits. f. Physik*, 61. 3–4. *pp.* 185–190, 1930.

From X-ray powder photographs it is deduced that solid CO has the same structure as the α-modification of solid nitrogen. The unit cell containing four molecules has an edge of 5·63 Å. and a density of 1·0288; space group T^4. W. H. Ge.

2731. New Rotating Crystal Method for Investigating Crystal Structure by Means of X-Rays. W. Linnik. *Zeits. f. Physik*, 61. 3–4. *pp.* 220–226, 1930.

By turning the crystals to and fro during exposure about two axes at right angles to one another diagrams are obtained which indicate the symmetry of the crystal, and which can be used in the investigation of the crystal structure. Crystal and photographic plate are connected rigidly together, and one of the rotations is about the normal from the centre of the crystal to the plate, this line being horizontal, and the other about a vertical line through the crystal. The beam of X-rays is horizontal. Hyperbolæ are traced on the photographic plate by the beams diffracted from the different planes of the lattice, and when the crystal is cut at or nearly at some definite orientation the figures due to the intersection of these lines are very definite and regular. H. N. A.

2732. Lattice Energies and Compressibilities of the Alkali Hydrides. J. Kasarnowsky. *Zeits. f. Physik*, 61. 3–4. *pp.* 236–238, 1930.

By means of the recent determination which Bethe [see Abstract 502 (1930)] has made of the electronic affinity of hydrogen (17 ± 1 kcal.), using the wave-mechanics method of Hylleraas, more accurate values for lattice energies can now be obtained, and these data, as well as compressibilities, have been calculated in the present paper for the hydrides of the alkalies and alkaline earths. The possibility of the direct experimental investigation of the Born lattice energies is indicated. H. H. Ho.

2733. Mixed Crystals CaF_2-SrF_2. E. Rumpf. *Zeits. f. phys. Chem.* 7. *Abt. B.* 2. *pp.* 148–154, *March*, 1930.

Determinations by the Debye-Scherrer method of the lattice constants of mixed crystals of calcium and strontium fluorides of various compositions prepared in different ways give results in agreement with Vegard's additivity law. T. H. P.

2734. Subsidiary Valency and Crystal Structure. E. Hertel and K. Schneider. *Zeits. f. phys. Chem.* 7. *Abt. B.* 3. *pp.* 188–209, *March*, 1930.

Shows that the subsidiary valency forces, which make it possible for the aromatic polynitro-bodies to form typical molecular compounds, take part also in building the crystal lattices of the nitro-bodies as lattice forces, which account for the existence of chain, net and lattice " building bricks." Models of the structure of the crystal lattices of dinitroxylol and of *m*- and *p*-dinitrobenzol are discussed in relation to space-group determinations made with the Weissenberg and Böhm X-ray goniometer. The characteristic symmetry of the molecule of dinitroxylol, the three dinitrobenzols, the trinitrobenzols and di- and trinitrophenol are compared. The conditions are considered for the possibility of comparing the lattice structures of chemically related substances. H. N. A.

2735. X-Ray Studies of Molybdenum and Tungsten Nitrides. G. Hägg. *Zeits. f. phys. Chem.* 7. *Abt. B.* 5. *pp.* 339–362, 1930.

X-ray studies of the nitrides of molybdenum and tungsten have been carried out on samples prepared by the action of ammonia on the metal. In the molybdenum-nitrogen system the phase poorest in nitrogen, the β phase, is homogeneous when it contains about 28 % (atomic) of nitrogen: it is stable only above 600° C. The molybdenum atoms are arranged in a face-centred tetragonal lattice. The next phase, in order of increasing nitrogen concentration, is the γ, which is homogeneous over a narrow range for nitrogen concentrations of approximately 33 % (atomic) at temperatures below 600° C. or 700° C. The metal atoms are arranged on a face-centred cubic lattice. The phase richest in nitrogen, the δ, contains about 50 % (atomic) of nitrogen. The metal atoms are arranged in a simple hexagonal lattice. It has not been possible to determine the position of the nitrogen atoms in any of the phases. Only the phase containing least nitrogen has been studied in the tungsten-nitrogen system. It is analogous to the corresponding molybdenum phase, since it contains about 33 % (atomic) of nitrogen and the metal atoms lie in a face-centred cubical lattice. F. J. W.

2736. Structural Connections within Crystal Structures. F. Laves. Parts I and II. *Zeit. f. Krist.* 73. 2. *pp.* 202–265, *Feb., and* 73. 3–4. *pp.* 275–324, *March*, 1930.

In Part I an extension is given of the work of Weissenberg [see Abstract 1423 (1929)]. His conception of " micro-islands " is considered ambiguous. The author divides structural elements into two classes: (*a*) finite, (*b*) infinite. A finite structural element (*a*) is conceived as a region of space partly or wholly filled with matter, bounded by a closed surface, such that all points lying within, and only those, belong to this particular structural element. It is arbitrarily postulated that no two identical points shall lie within an element of type (*a*), so that it can at most possess the contents of a simple primitive range. Infinite structural elements (*b*) are of three kinds:

(1) one-dimensional, (2) two-dimensional, (3) three-dimensional. (1) is an (infinite) cylindrical region partly or wholly filled with matter, subject to the condition that it shall only contain such identical points as can be derived from each other by translation; (2) is an infinitely extending region composed of layers, subject to appropriate conditions of content as before; (3) comprises entire space. In general, every material particle is to be assigned to one structural element at most. The remainder of the paper is devoted to showing how the above-indicated partitions can be used to derive all possible structural connections as functions of the axial ratios and axial angles of the crystal. Part II deals with applications to elements, binary compounds, and a number of more complicated cases. This formal treatment leads to a number of relationships between the crystal structure and the periodic system of the elements. F. I. G. R.

2737. Systematic Structure Theory. H. Heesch. *Zeits. f. Krist.* 73. 3–4. *pp.* 325–356, *March*, 1930.

Deals with an extension of the Schœnflies system of space groups, which makes it possible to regard problems of chemical complex structure from a new standpoint. Just as in considering symmetry in a plane one may first take the ordinary two-dimensional problem, and then in dealing with ornamental patterns treat them by introducing a third " dimension " when the ornaments are differently coloured to record the arrangements of the colours, so in a crystal the position of the ions can be recorded in the ordinary three-dimensional space groups, and a fourth " dimension " can be introduced, which makes it possible to record not only the geometrical symmetry of the configuration, but also to describe the distribution symmetry of the A relatively to the B ions. Rock-salt and zincblende, for example, fall into two different four-dimensional groups, since they have different distribution symmetries. The symbols made use of are explained. The latter part deals with the nature of semi-discontinuous space systems. A semi-discontinuum is defined as a space form in which identity distances occur, which, however, are not all greater than a very small given distance. Examples are given and the symbolism is explained. [See also Abstract 1306 (1930).] H. N. A.

2738. Radii Quotient of Particle Groups and Coordination Number. T. Ito. *Zeits. f. Krist.* 73. 3–4. *pp.* 365–375, *March*, 1930.

A mathematical treatment of isogonal particle groups. [See Abstract 35 (1930).] A. J. M.

2739. Structure of Some Complex Cyanides. C. Gottfried and J. G. Nagelschmidt. *Zeits. f. Krist.* 73. 3–4. *pp.* 357–364, *March*, 1930.

The structures of potassium ferri-, chromi-, mangani-, and iridicyanides, and of cæsium ferricyanide, have been examined by X-ray methods. The unit cells of the four potassium salts contain four molecules each, (a, b, c) measuring respectively (13·42, 10·40, 8·38); (13·55, 10·60, 8·60); (13·56, 10·60, 8·50); and (13·70, 10·53, 8·34). The three last are rhombic, V_h^{14}, and strictly isomorphous. Potassium ferricyanide is monoclinic ($\beta = 90°06'$), C_{2h}^5, and pseudorhombic, its deviation from true rhombic being apparent in the extinctions due to a few high-indexed faces. This is attributed to a slight molecular association of each pair of molecules, $K_3Fe(CN)_6$, in the solid crystal. The coordinates of the heavy metals (deduced from those of the iridicyanides) are 000, $\frac{1}{2}00$, $0\frac{1}{2}\frac{1}{2}$, $\frac{1}{2}\frac{1}{2}\frac{1}{2}$. Cæsium ferricyanide ($d_{20°}$ 2·450 ± 0·003), though rhombic, is not isomorphous with

the other salts examined; the unit cell contains two molecules, and has $(abc) = (11\cdot8, 10\cdot1, 7\cdot0)$. C. A. S.

2740. Homogeneous Symmorphous Structure-Nets and Lattices. P. Niggli and F. Laves. *Zeits. f. Krist.* 73. 3–4. *pp.* 381–427, *March*, 1930.

Homogeneous lattices, composed of material particles having a common centre of gravity and showing the symmetry of translational groups, are defined as system-symmorphous lattices. Their properties are discussed, particularly with regard to coordination number, *i.e.* the number of particles of kind A which surround another particle of kind B symmetrically in the crystal lattice. Tables and diagrams show the relation of co-ordination to space-group theory, and the relation of both to crystal structure. The type of coordination actually found is recognised to be a function of the attractive and repulsive forces. F. I. G. R.

2741. Allotropic Modifications of Sulphur. C. R. Platzmann. *Chem. Soc. Japan, Bull.* 5. *pp.* 43–47, *Feb.*, 1929. *In German.*

Reference is made to the work of Smith and his co-workers, who showed that sulphur dioxide retarded and ammonia accelerated the melting-point equilibrium. These observations are confirmed and more fully studied in the present work. [See also Abstract 1732 (1930).] J. K.

2742. Thirty-Sixth Annual Report of the Committee on Atomic Weights. Determinations Published During 1929. G. P. Baxter. *Am. Chem. Soc., J.* 52. *pp.* 857–862, *March*, 1930.

Pire and Moles, by determining the normal density of CO, have recently found 12·006 for the atomic weight of carbon, it is recorded by the American Chemical Society as 12·00. Richie has found 30·98 for the atomic weight of phosphorus, the Am. Chem. Soc. table gives 31·02. Chlorine, Scott and Johnson, 35·457, which is adopted by the Am. Chem. Soc. Argon, Baxter and Starkweather, 39·944, Am. Chem. Soc., 39·94. Nickel, terrestrial and meteoric, Baxter and Ishimaru, 58·694, Am. Chem. Soc., 58·69. Copper, Richards and Phillips, 63·557, Am. Chem. Soc., 63·57. The table of the English Committee differs noticeably from recent German and American tables, as Clarke's Recalculation of the Atomic Weights is made use of, with modifications in view of recent work, and in some cases Aston's results with the mass spectrograph are given. H. N. A.

2743. Atomic Weight of the Oxygen Isotope, O^{18}. R. Mecke and K. Wurm. *Zeits. f. Physik*, 61. 1–2. *pp.* 37–45, 1930.

The atomic weight of the oxygen isotope O^{18} is found to be 17·991 $\pm$ 0·010, taking the normal atomic weight of O^{16}· to be 16·000. This result is obtained from accurate spectroscopic data regarding the atmospheric oxygen bands at 7600 Å., usually termed the A– and A^1 groups. An accuracy of 1 in 10,000 can be obtained in atomic weight estimations, using this method of band analysis. R. C. F.

2744. Simple Eigenfunction for the Fundamental State of the Lithium Atom, and of Ions with Three Electrons. V. Guillemin, Jr., and C. Zener. *Zeits. f. Physik*, 61. 3–4. *pp.* 199–205, 1930.

Starting from a function which has the correct asymptotic behaviour for large distances between the nuclei, the author arrives at a simple eigenfunction for lithium, and the ions Be^+, B^{++} and C^{+++}, which resemble this atom in external structure. Certain parameters occur, the

values of which are determined by means of a variation method. The function so obtained is used to calculate the energy required to separate the valency electrons. For lithium the value 5·32 volts is obtained; the observed value is 5·37 volts. H. N. A.

2745. Equations of the Quantum Theory. J. W. Fisher and H. T. Flint. *Roy. Soc., Proc.* 126. *pp.* 644–653, *March* 3, 1930.

Continues the application [see Abstracts 2372 and 2963 (1929)] of the five-dimensional system of coordinates to the discussion of certain points and difficulties in the quantum theory. Klein has shown that in a five-dimensional system the track of an electron in an electromagnetic field is a geodesic, and that the fundamental second-order equation of the quantum theory for the case of a non-rotating electron enters very simply into the theory. A modification in the symbols introduced by the authors makes the track of a charged particle a null geodesic, and there is an analogy between the motion of a particle in five dimensions and of a ray of light in four. The wave equation of a quantum, which is the well-known equation for a light wave, is easily obtained; and the corresponding equation in five dimensions is the wave equation for a non-rotating electron in an electromagnetic field. The main object of the paper is the development of the assumption that there is a system of equations in the five-dimensional system which resembles the equations of the electromagnetic theory in the four-dimensional system. It is shown that Dirac's equations can be based on the general invariant system proposed by the authors, and that it is unnecessary to introduce arbitrarily any terms and operators to account for quantum phenomena, which are associated with the metrics of space. H. N. A.

2746. Operational Calculus in Quantum Mechanics. R. B. Lindsay and R. J. Seeger. *Nat. Acad. Sci., Proc.* 16. *pp.* 196 204, *March,* 1930.

The operational methods of Hilbert, v. Neumann and L. Nordheim are discussed and somewhat generalised. Some special problems are solved by these methods. The general problem of the determination of canonical variables, p, q., *i.e.*, variables satisfying the relation $pq - qp = h/2\pi i$, in these theories is attacked. A tentative solution is given in the course of which occur some solutions of differential equations with non-permutable variables. G. C. McV.

2747. Interpretation of the Experiments of Sagnac and of Michelson. Corps. *Comptes Rendus,* 190. *pp.* 623-625, *March* 10, 1930.

A mathematical analysis of the experimental conditions of the experiments of Michelson (1924) and of Sagnac indicates that the results of these experiments are in agreement with the principle of universal simultaneity. J. S. G. T.

2748. Einstein's Gravitational Equations. T. Levi-Civita. *Accad. Lincei, Atti,* 11. *pp.* 3–12, *Jan.* 5, *and* 113–121, *Jan.* 19, 1930.

An attempt to apply Volterra and Hadamard's theory of characteristics to the gravitational theories of relativity. E. E. F. d'A.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

2749. Persistence and Co-Aggregation of Fog and Cloud. A. Wigand and E. Frankenberger. *Phys. Zeits.* 31. *pp.* 204–215, *March*, 1930.

The author considers first the magnitude and sign of the electric charge for fogs and finds that when persistent the drop charge is high, of the same sign and exceeds a certain limiting value. When the fog or cloud is thickening the drop charge is small, and below the limit and the sign variable. The effect of the electric double layer and Smoluchowski's views on these results are considered. A comparison is next made of Arendt and Kallmann's results with those of Wigand and Wittenbecher on the drop charge and the space charge in clouds. Smoluchowski's laws regarding the combination of drops are then applied to the cases of (1) diffusion and Brownian movements with air at rest and having stratification, and (2) turbulent or shearing motion in the air. This theory is applied to the experimental measurements of Wigand and Wittenbecher, and in a table are set out: (1) kind of fog, thickness and visibility; (2) notes on moisture; (3) wind velocity; (4) drop radius and charge; (5) limiting charges for thermal and turbulent motion. In some cases the drop charge prevents co-aggregation, but in others it assists. The results agree with Kohler's. Finally, the co-aggregation for uncharged rain clouds is considered according to Smoluchowski's formula for thermal and turbulent motion. [See Abstracts 1083 (1926) and 49 (1929).] R. S. R.

2750. Transparency of the Lower Atmosphere. H. Buisson, G. Jausseran and P. Rouard. *Comptes Rendus*, 190. *pp.* 808–810, *March* 31, 1930.

Using the mercury arc in quartz as source spectra were obtained in two identical vessels, one 600 and the other 2500 m. distant. A photographic plate was halved and one half put in each vessel. The illuminations at these distances were equalised by inserting one or more plates of quartz coated with Pt by kathodic projection. The spectra obtained were measured by a microphotometer. The differences of absorption were due to the air column 1900 m. long, and its logarithm gives the optical density of the air. In a table for different wave-lengths are given (1) total optical density per km., and (2) density relative to pure absorption after deduction of that due to molecular diffusion. The absorption is feeble down to 2900 Å., but then increases rapidly. It is not due to ozone, because the maximum at 2500 Å. is not shown, but it is probably the beginning of the large oxygen band. Values in a fog are greater, but there is little selection. The results are greater than those of Schaeffer, Dawson, Granath and Hulburt. [See Abstracts 101 and 102 (1930).] R. S. R.

2751. Direct Measurement of Atmospheric Absorption. Link and Hugon. *Comptes Rendus*, 190. *pp.* 810–813, *March* 31, 1930. *Rev. d'Optique*, 9. *pp.* 156–163, *April*, 1930.

Using a 100-watt lamp at the Pic du Midi the relative brightness was measured on ten nights at 900 m. and 31 km. If E is the brightness of the screen, r the distance, I the intensity of the source and α the coefficient of atmospheric absorption, then $E = Ie^{-\alpha r}/r^2$, while the optical density $d = \log (E_2/E_1) - 2 \log (r_1/r_2)$. Values of E_2/E_1 were found with a

photometer. For three wave-lengths d and α were obtained on each night. It was found that the absorption diminished from the blue to the orange and then less rapidly, the relative absorption being a maximum in the orange. The variations of α from night to night are very large. The values of α so found were compared with those obtained by (1) an astronomical method and (2) the Rayleigh-Cabannes formula, and give general agreement. R. S. R.

2752. Actinometer Measurements and their Relation to the Turbidity of the Atmosphere. A. Ångström. *Gerlands Beitr. z. Geophys.* 25. 3–4. *pp.* 261–265, 1930.

The author quotes an expression which gives an integrated value for all wave-lengths of the total radiation received at the earth's surface, a correction being introduced for the selective absorption due to water vapour. The expression involves a factor (β) termed the coefficient of turbidity which can be calculated by using experimental measurements of radiation in conjunction with the general equation. It was found that at sea-level β decreased from (0·12–0·15) at the equator to (0·10–0·11) at 40° N. and (0·04–0·05) at Spitzbergen. It was less at the tropics over the sea than over land. It had a maximum value in spring and early summer (April–June) and a minimum in early winter (November–December), It decreased with height, reaching half value at 1000 m. At Stockholm its variation gave an indication of the origin of the air ranging from 0·059 for northerly to 0·088 for southerly winds. R. S. R.

2753. Spectral Composition of Diffused Light During Twilight. N. N. Kalitin. *Gerlands Beitr. z. Geophys.* 25. 3–4. *pp.* 348–359, 1930.

Measurements were made with a Weber photometer of the total brightness of the sky and the part transmitted through red, green and blue filters at Pawlowsk. The ratio of the brightness of each colour to the total brightness and of the blue to the red was determined for solar heights near to zero and for overcast and cloudless skies. The ratio (blue/red) with the sun at 5° for a cloudy sky is half the value for a clear sky. With a cloudy sky for solar heights 10° to 5° the red and blue decrease almost equally, but from 5° to − 2·5° the red decreases more rapidly. With a cloudless sky the ratio alters little until the sun is 1–2° below the horizon and then increases rapidly, the red again decreasing more rapidly. The scattering in clear skies follows Rayleigh's law and is a maximum for short wave-lengths, but in cloudy skies it is the same for all wave-lengths. Consequently, with the onset of night the diffused light becomes relatively richer in blue. R. S. R.

2754. Calculation of Exchange Coefficient from Fine Registration of Turbulent Variations. H. Ertel. *Gerlands Beitr. z. Geophys.* 25. 3–4. *pp.* 279–289, 1930.

The proposition is deduced that the variations connected with turbulence of the different characteristics of the turbulently streaming mass are related as the vertical gradients of these characteristics. Then a method is developed which renders possible the calculation of the exchange coefficient from the fine registration of the turbulent variations, if at the same time the vertical gradient of the characteristic, whose variations are registered at a fixed point of the field of streaming, is known at this point. J. J. S.

2755. Influence of Positive and Negative Accelerations on Local Solid Rotating Liquid Columns. J. Letzmann. *Gerlands Beitr. z. Geophys.* 25. 3–4. *pp.* 360–413, 1930.

Besides a more accurate limitation of the surrounding components of the geophysical whirlwind and the establishment of four kinematic types of core, the acceleration relations in waterspouts in general and their connection with the types of core are considered. After establishing a method in which a transfer of energy to a waterspout is possible, an analytical result is replaced by experiment. The kinematic changes in non-accelerated liquid columns are investigated experimentally for added positive or negative accelerations in the cases of (1) plane ground and surrounding surfaces, and (2) cylindrical edges. Besides the frictional limitation of the vertical movement and its form in case (1), a discontinuous velocity distribution, non-turbulent but possessing a stable form of motion, two kinds of vortices are established for case (2) when limited by the acceleration relations. The results of Taylor, as extended by Terada and Hattori, in reference to the kinematic relations in the surroundings of the rotating cylinder are applied to the conditions of movement in the surroundings of the waterspout. R. S. R.

2756. Dispersion of Seismic Waves of Love Type and Thickness of Surface Layers of the Earth below the Pacific. P. Byerly. *Gerlands Beitr. z. Geophys.* 26. 1. *pp.* 27–33, 1930. *In English.*

The velocities of the first wave of Love type deduced from the records of 20 earthquakes at Berkeley (Cal.) with origins distant at least 60° have been compared with the result of calculations based on the assumptions that the velocity of distortional waves in the lower and of simple shear waves in the upper surface layer of the earth below the Pacific are 4·7 and 4·0 km./sec. respectively, the densities 3·3 and 3·1, and that the wave- and not the group-velocity has been observed. The results point to the surface layer having a thickness of approximately 40 km. If possible, heterogeneity [see Abstract 742 (1929)] is considered, the approximation is better. If it is group- and not wave-velocity that has been observed, a thickness of 20 km. gives the nearer result. C. A. S.

2757. Free Oscillations of Surface Excited by Seismic Waves. K. Sezawa. *Tokyo Univ. Earthquake Research Ins ., Bull.* 8. 1. *pp.* 1–11, *March*, 1930.

The simple case, in which a dilational pulse of a purely plane type propagated vertically upwards in an elastic solid medium is partly transmitted through the base of a superficial layer and partly reflected there, is investigated. When the length of the disturbed portion of a primary wave is small compared with the depth of the layer, the displacements are of periodic pulsation types. When the extent of the primary disturbance is large compared with the depth of the layer, no periodic pulsation can be obtained. The oscillations have a decaying character, and differ according to the rigidity of the layer. W. A. R.

2758. Possibility of Block Movements of the Earth's Crust. K. Sezawa and G. Nishimura. *Tokyo Univ. Earthquake Research Inst., Bull.* 8. 1. *pp.* 13–43, *March*, 1930.

In 1924 Sezawa studied earthquake motions in which the energy of the seismic waves is radiated in succession from multiple sources consisting of a series of land blocks of a few km. filling the faulted region, with par-

ticular reference to the Kwanto earthquake of 1923. The block movement has been investigated by others in Japan, and the present mathematical analysis leads to the following conclusions. Bodily movements of very rigid blocks of the earth crust are impossible; the crust cannot be regarded as a mosaic work. The deformation of the surface must in general be curved. In particular cases of boundary conditions or of heterogeneously distributed rocks of various rigidities, surface displacements of discontinuous character may be combined with the general curved flexure. Sliding of the blocks in contact can hardly take place under the action of extraordinary pressures, unbalanced isostatically, at the bottom of the blocks. As the ratio of the depth to the breadth of a block increases, the surface displacement diminishes abnormally, and sliding of the surfaces of contour becomes more impossible. Sliding of the fault in the vicinity of the surface becomes possible with unbalanced forces acting horizontally at the surface of the contact, while the deep portion of the ground is not yet capable of sliding. Thus the evidence of faults, deduced from earthquake movements and slow deformation of the crust, is of a superficial nature. The actual deformation data used refer to the Tango district.

H. B.

2759. Nature of Destructive Earthquakes. T. Terada. *Tokyo Univ. Earthquake Research Inst., Bull.* 8. 1. *pp.* 61–73, *March,* 1930.

Estimating the intensity of seismic disturbances by the percentage damage to wooden houses, the hypothesis that destructive earthquakes are the marginal phenomena of block motion of the crust, the chief sites of disturbance being localised in a series of narrow zones along the surface boundaries of the blocks, is examined with reference to several destructive earthquakes in Japan. Maps showing the areas of greatest destruction, *e.g.*, over 50 % of houses destroyed, are given showing that many of such areas are of long and narrow outline rather than the traditional oval around an epicentre. The alignment of faults and results of levelling also support the hypothesis.

C. A. S.

2760. Thermal Instability of the Earth's Crust. J. H. J. Poole. *Roy. Dublin Soc., Proc.* 19. *pp.* 385–408, *March,* 1930.

In a previous paper [see Abstract 1856 (1928)] the author connected the stability of the earth's crust with the relation between the increase of melting-point temperature of basalt with depth and the increase of temperature with depth in a column of liquid basalt in adiabatic equilibrium. If the former gradient be the greater, as it appeared probable, then a basaltic crust containing more than a definite proportion of radioactive material should not attain a stable temperature, but should pass through a series of partial liquefactions and resolidifications. The simpler mathematical problem now examined is: given a long vertical column of a crystalline solid, containing a definite proportion of radioactive material, enclosed on all sides, with closed bottom and open top, and given the state of the system at some time, determine its past and future history. A column about 200 km. is examined having a thin liquid layer at the base. Melting would take place probably in small cells, scattered through the whole mass of the column, proceeding upward at a very slow rate, from 1 to 500 km. per million years, so that there would be some liquid layer between two solid blocks at any time. Heat escape from the earth's surface, and the rate of sinking of a given geotherm are not supposed to take place on the lines of Cotter [see Abstract 2939 (1924)]. At the present

time the liquid is supposed to have risen nearly to the surface, the solid crust above being only 1·2 km. in thickness as a minimum value. The radioactivity of the column below the equilibrium position of the melting point geotherm mainly controls the period of a thermal cycle. But the crust is not crystalline, as had been assumed in the calculations, and its melting in an indeterminate manner makes all determinations of thermal cycles very uncertain, though they would not be contrary to the laws of heat. H. B.

2761. Measurement of Electromagnetic Fields of an Alternating Current. A. Belluigi. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 1. 1. *pp.* 4–8, 1930.

A simple method is described for measuring the electromagnetic field of an alternating current in geoelectric researches. As it has not been found possible to suppress the influence of the current in the conductors a method for measuring this is given which is practically effective. J. J. S.

2762. Geoelectric Methods with Direct-Current Conduction. J. Koenigsberger. *Gerlands Beitr. z. Geophys. Angew. Geophys.* 1. 1. *pp.* 23–109, 1930.

The magnetic field of a dipole of a stationary electric current sent into the earth was calculated and this theoretical field compared with the observed field of an alternating current of 400–500 H frequency. The difference is due to the skin effect, which can be divided into two separate effects: the first due to the effect of the current which is flowing through the wire between the two earth electrodes on the current lines in the earth; the second due to the mutual induction of the current lines in the earth. The first can be observed near the dipole axis, the second at a greater distance from the wire on the prolongation of the axis. Theoretically it may be concluded that a general enlargement of the dimensions with an unchanged frequency is equal to a higher frequency with original dimensions. Therefore a greater length of the dipole axis always gives greater skin effects. This is proved experimentally. A better conducting soil also gives a greater skin effect than a poorer conducting one. The use of low frequencies is preferred to methods with high frequencies. With low frequencies the change of phase is small except where ore is concealed below the surface. H.f. current does not penetrate deeply enough into the earth. The change of resistance in parallel, horizontal, infinite layers is deduced by two methods. Some calculations are given for finding the depth of a more or less conducting body from the deviations of the observed field lines compared with the normal field direction. Insulators such as oil and gas-bearing strata and deposits and their upper migration zone also cause deviations of the field lines. A stretch of boggy land or a shallow lake disturbs slightly the horizontal field, but the vertical field component is much affected by shallow inhomogeneities. Topography and geological structure exercise strong effects. J. J. S.

2763. External Gravitational Field of the Ellipsoidal Geoid. C. Somigliana. *Accad. Lincei, Atti*, 11. *pp.* 237–243, *Feb.* 2, 1930.

Mathematical calculations of the property of the field of the ellipsoidal geoid. The law of distribution of the normal component of gravity is the same on all the ellipsoids homofocal with the geoid ellipsoid—it depends in an identical way on the semi-axes of such ellipsoids and on the values of gravity at the pole and at the equator of these. Also, in the case of ellipsoids with three axes, the identity of the law of distribution holds good.

An expression for gravity analogous to that valid on the surface of the geoid continues to subsist even in the external regions sufficiently near to that surface. J. J. S.

2764. Form of the Geoid. M. Bossolasco. *Gerlands Beitr. z. Geophys.* 26. 1. *pp.* 14–26, 1930. *In Italian.*

The measurements of gravity and the existence of gravity anomalies are considered in relation to the problem of determining the figure of the earth. W. A. R.

2765. Reduction and Numerical Evaluation of Observed Values of Gravity. F. Hopfner. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 25. 3–4. *pp.* 339–347, 1930.

It is shown that from results of gravity measurements in connection with the theorems of Clairaut and Stokes one can find synthetically the shape of the surface extending at sea-level, without the help of the hypothesis of distribution of masses inside the earth. Doubts regarding isostatical distribution of mass inside the earth could be decided by this method of computation since the magnitude of the curvature at this level could be found. R. S. R.

2766. Use of Floating Mirror with the Transit Circle. H. C. Woods. *Roy. Astron. Soc., M.N.* 90. *pp.* 538–552, *March,* 1930.

Indicates a means of substantially improving the accuracy of time determinations with the transit circle, by including a reflection observation of the zenith, the determination of level thus being more symmetrical and independent of the collimation. A mirror mounted so as to float upon mercury is used for observing the zenith and horizontal points directly with the transit circle, reflection at a mercury surface being used for observing the nadir. The construction, adjustments and accuracy of the floating mirror are described, as is the method of mounting the float at the zenith. Observations of level are given, and, finally, other uses of the floating mirror are discussed. R. C. F.

2767. Mechanical Method for Assisting in the Determination of Parabolic Orbits. M. Davidson. *Roy. Astron. Soc., M.N.* 90. *pp.* 562–567, *March,* 1930.

A mechanical model has been constructed with which an approximate determination of a comet's orbit can be made, and is described and illustrated. If the approximate values are employed in the usual equations, accurate values can be derived with considerable simplification of the calculations. The model is also interesting because it shows the reasons for various stages in computing an orbit and the occasional difficulties in determining the elements very accurately. M. A. E.

2768. Anomalous Rotation of the Sun. R. Gunn. *Phys. Rev.* 35. *pp.* 635–642, *March* 15, 1930.

The requirements of Jeans' theory of the anomalous solar rotation are not in accord with the facts of solar magnetism. A new theory is worked out which attributes the anomaly to atmospheric motions arising from the interaction of ions with the solar magnetic field and an assumed electric field. Observations of the solar atmosphere are made only in those regions where the gaseous pressure is such that the ion free paths are long. Ions of both kinds which execute long free paths in crossed electric and magnetic fields are swept in the same direction and give rise to a mass

motion. This superimposed drift of the solar atmosphere is shown to account for the rotational anomaly, and the calculated variation of the angular velocity with latitude is of the observed form. The theory requires that the sun possess a radial electric field having a sign and distribution similar to that observed on the earth. AUTHOR.

2769. Photographic Study of Solar Spectrum Between λλ10,000 and 11,000 Å. H. D. Babcock. *Phot. J.* 70. *pp.* 126-131; *Disc.*, 131, *March*, 1930.

The author describes previous work as low as λ9867 by Abney, who used a red glass filter and made his own emulsion, and by Burns, Meggers and Brackett, none of whom got so low, Brackett's furthest being λ9849. The later investigators used ordinary emulsions stained with dicyanine, and Brackett used preliminary dispersion instead of a filter to remove undesirable radiation, but neither Abney nor Brackett used Tyndall's effective filter. The author employs a new infra-red sensitiser, neocyanine (highest sensitivity about λ8300), and a new liquid filter (neocyanine soluble in chloroform), both from the Eastman Laboratory; his apparatus consists of a two-prism spectrograph of small scale recording the solar spectrum out to λ11,500 with a five-minute exposure, and a concave grating spectrograph of large scale which requires five to seven hours' exposure, on plates treated with ammonia, to give a negative measurable at λ11,000. Such photographs have given the positions and approximate intensities of 350 lines between λλ9867 and 11634, where in the same region the bolometer shows only 96 lines of which some are doubtful. On his photographs have been recognised the strongest multiplet of carbon, and two phosphorus lines, the first indication of the presence of this in the sun. In the *Discussion*, **O. Bloch** describes how the bands of maximum sensitivity get narrower as sensitisation is carried further into the infra-red, and points out that extraordinarily small quantities of dyestuff are necessary to introduce maximum sensitivity in a new region; increasing the dyestuff means increase of fog. A. S. D. M.

2770. Calculation of Relative Temperatures and Pressures at Sunspot Bases. R. M. Petrie. *Roy. Astron. Soc., M.N.* 90. *pp.* 480–487, *March*, 1930.

The author computes the parameters, pressures and temperatures according to three successive degrees of approximation: (1) he takes for the photosphere, $T \propto P^{1/4}$ and for sunspots $T \propto P^{(\gamma-1)/\gamma}$, and computes P_0/P_1 from $T_0 = T_1(T_1/T_1')^{\gamma/(3\gamma-4)}$; (2) he uses the equation of radiative equilibrium $T^4 = \frac{1}{2}T_e(1 + \frac{3}{2}\tau)$, where T_e is effective temperature and τ is optical depth; (3) he modifies the treatment so as to take into account the pressure-difference between the tops of the photospheric and sunspot columns, for since the spot is cooler than the surrounding photosphere its surface pressure is less, though the sunspot column base remains at the same temperature and pressure as the photospheric at that level. For the general atmosphere $T \propto P^{4/17}$, and for the spot $T \propto P^{(\gamma-1)/\gamma}$. He adopts three values of γ (5/3, 3/2, 7/5), and finds that the changes T_0 and P_0 with change of γ are successively less marked with the three degrees of approximation. With $\gamma = 5/3$ (monatomic gas), the pressure at the sunspot surface is about 7×10^{-5} atmos. and the maximum rotation velocity of an equatorial spot is 0·8 km./sec. With departures from monatomic gas conditions, sunspots would have to originate at greater depths than the observed

temperature-differences of spot and photosphere allow. [See also following Abstract.] A. S. D. M.

2771. Preliminary Note on Sunspot Structure. E. A. Milne. *Roy. Astron. Soc., M.N.* 90. *pp.* 487–496, *March*, 1930.

The author confirms Petrie's results of pressure, temperature and linear depths [see preceding Abstract], and provides an evaluation of Evershed's velocity of outflow. He classifies characteristic sunspot phenomena and gives a diagrammatic vertical cross-section of spot circulation, which must be hydrodynamically steady (locally) to account for its semi-permanence; this is possible if the rate of increase of temperature down the core exceeds that down the edge, so that there is a level at which the one overtakes the other. Down a column in adiabatic equilibrium (in the presence of radiation-pressure) the density increases asymptotically towards a maximum, radiation-pressure becoming increasingly dominant to gas-pressure, and p/ρ^{γ} increases, so that the temperature no longer increases linearly with depth; but in radiative equilibrium the photospheric layers have a temperature distribution nearly linear. He gives a diagram for the determination of the umbra base; he finds that the cyclonic motion set up by solar rotation is negligible as compared with velocity of outflow, for the three values of γ; these are 1·0, 1·3 and 1·6 as compared with Evershed's 1·8 km. sec., but this does not allow that the gas should be largely hydrogen. The outflow velocities will give ultimately the mean molecular weight of the gases present with exactness. The spot umbra is penny-shaped, not columnar. A. S. D. M.

2772. Lunar Radiation and Temperatures. E. Pettit and S. B. Nicholson. *Astrophys. J.* 71. *pp.* 102–135, *March*, 1930.

From the planets, reflected sunlight lies between 0·3 and 5 μ, " planetary heat " between 5 and 14 μ (except for Mercury). The authors investigate transmission coefficients, observational data and measurements; and find for planets that $\log T = 2{\cdot}612 - 0{\cdot}1\,(\overline{m}_r - \Delta\,\overline{m}_r)$, where $\overline{m}_r$ is the radiometric magnitude of the solid angle 1 sq. sec. of arc of planetary heat. They plot drift curves for the moon of planetary heat with or without a fluorite screen, and infer that the silica content of the lunar crust is in the form of finely divided sand or pumice. The distribution of planetary heat over the full moon disc follows the law $E = a\cos^{3/2}\theta$ and not $E = a\cos\theta$, the difference being due (at least qualitatively) to the roughness of the lunar surface. From the centre to 0·95 radius, the temperature varies between 400° and 320° K. (of the dark side is about 120° K.), and for the subsolar point at 1st quarter is 49° C. lower than at full (407° K. agreeing with Menzel's water-cell results). Eclipse observations show that the lunar surface materials have low heat conductivity. For the lunar surface the observed planetary heat is 17° higher than theoretical, indicating that the atmospheric transmission between 8 and 14 μ is 19 % high, and thus the radiation temperatures should be lowered: Mercury by 45°, Venus 9° and Mars 10°. The radiometric magnitude of the full moon reflected light is −13·3, of the whole radiation −14·8, the albedo of the subsolar point is 0·124 and the radiometric albedo of the full moon is 0·093. A. S. D. M.

2773. Trans-Neptunian Planet. E. Esclangon. *Comptes Rendus*, 190. *pp.* 834–836, *April* 7; 897–901, *April* 14; *and pp.* 957–958, *April* 23, 1930.

Micrometer measurements on photographs of the planet at the Paris

Observatory showed that a minimum of right ascension was passed at 30·5 March. The earliest calculations gave a circular orbit with a revolution in 489 years. Using the Laplace method Mineur and Canavaggia showed that the velocity was sensibly constant in speed and direction in the first 18 days of observation. A parallactic method was employed, and Stoyko found (1) the heliocentric coordinates of the planet referred to the ecliptic and the equinox; (2) the distance from the sun R (44,400); (3) the longitude of the node Ω (108° 55′); and (4) the inclination i (38° 54′). Of these only R and Ω are reliable, and many months or years of observations are needed to fix the true nature of the orbit. Later, using pairs of observations on either side of the minimum, Stoyko found by the Lagrange method, as modified by Noumeroff, R = 41524, Ω = 109° 16′ and i = 19° 51′. Mineur found similar values by an analogous method. [See also following Abstract.] R. S. R.

2774. Determination of Position and Elements of a Planet or Distant Star. Application to the Lowell Celestial Body. E. Esclangon. *Comptes Rendus*, 190. *pp.* 981–985, *April* 28, 1930.

Reference is made to an earlier paper [see preceding Abstract] in which the speed and direction of a planet, supposed constant, and not affected by gravity, are found. In the present paper formulæ are obtained wholly analogous to those using the parallactic method, but in which note is taken of the first derivatives of speed (supposed variable) determined by the laws of gravitation. It is not claimed that easy corrections are made to the times figuring in the data, to take account of the aberration affecting the observed direction of the data. R. S. R.

2775. Relation Between Geocentric and Heliocentric Velocities and Heights of Fireballs. V. A. Maltzev. *Roy. Astron. Soc., M.N.* 90. *pp.* 568-575, *March*, 1930.

This investigation is based on materials obtained from the Fireball Catalogue of Niessl and Hoffmeister, which was criticised by W. J. Fisher in *Harvard Circular* 331, 1928. Fisher considered that the majority of geocentric velocities which implied hyperbolic heliocentric velocities were erroneous, but this contention is shown to be insufficiently grounded, and Niessl's conclusion with regard to the increase of heights of the appearance and disappearance of fireballs as dependent on the increase of their geocentric velocities is fully confirmed. The geocentric velocities being equal, the heights of appearance and disappearance depend on the heliocentric velocities, and the greater these are the higher the point at which fireballs appear and the lower the point at which they disappear. This may be accounted for by the hypothesis that (*a*) fireballs having greater heliocentric velocities are, on the average, of greater mass; (*b*) meteors of greater mass, other things being equal, appear at the greater height. M. A. E.

2776. Stellar Dynamics. V. Nobile. *Accad. Lincei, Atti*, 11. *pp.* 12-18, *Jan.* 5, *and* 128–133, *Jan.* 19, 1930.

A new and simplified statement of the problem of referring proper motions of stars to a fundamental trihedron based upon the sun.

E. E. F. d'A.

2777. Modern Theory of Evolution of the Stars. G. Armellini. *Accad. Lincei, Atti*, 11. *pp.* 232-237, *Feb.* 2, 1930.

The results of observation show that the stars during the first phase of their existence (giant stars) have large volume, very small mean density

and great brightness. In process of time the brightness decreases slowly but steadily, whilst the density increases. The effective temperature of the photosphere, measurable by spectro-photometric observations, shows a more complex variation: it increases, attains a maximum, commences to decrease (dwarf stars). Jeans has brought forward a theory founded on graphical methods to explain these facts. The author in the present paper takes up again the problem of Jeans and treats it not graphically but by rigorously analytical methods, which support the new theory of the transformation of mass into energy as an explanation of the results of observation. J. J. S.

2778. Statistical Properties of Double Stars in Space. W. J. Luyten. *Nat. Acad. Sci., Proc.* 16. *pp.* 252–261, *March*, 1930.

Hertzsprung first determined the median period of binaries in space; the author uses statistical methods with Kepler's 3rd law on near binaries of known parallax. The orientation of their orbits is taken as random, since there is no evidence of favoured direction; but not so with radii vectors in orbits of great eccentricity, since the star is more easily caught at apastron, and therefore the probability of any radius vector is taken as inversely proportional to the momentary angular focal speed. He finds $\log P = 1{\cdot}460 \log d - 0{\cdot}487 \log M + 0{\cdot}168 \pm 0{\cdot}35$ (common logs), which allows the calculation of a binary system from the angular separation, the parallax and the luminosity with an uncertainty of 0·40 in the logarithm; its usefulness is not limited to stars of known parallax. The author applies it to 47 binaries, and gets a median period of 2·51 and an arithmetic mean of 2·57 (this close agreement is probably accidental as the distribution is irregular), and he concludes that the median mean period is near 2·5 and corresponds to a little more than 300 years, whilst the dispersion in these logarithms is probably about 1·70; half the binaries in space may be expected to have periods between 20 and 4000 years. A. S. D. M.

2779. Spectrophotometric Study of A Stars. Emma T. R. Williams. *Harvard Coll. Obs., Circ. No.* 348. [34 *pp.*], *Sept.*, 1929.

In order to reclassify the brighter A stars on a more nearly physical basis, the contours of some of their lines have been studied and relative differences have been established. With stars from B8 to A2, the hydrogen lines are found to become progressively broader as one passes from more luminous to less luminous stars; and this, which is doubtless due to Stark effect, gives a criterion for determining their absolute magnitude. The K line and the line 4227 of calcium are relatively insensible to absolute magnitude effects at these temperatures, and hence they are good temperature indices. Some characteristics of "peculiar" stars can now be understood. A seasonal variation in colour measures has been detected. Instances have been found in certain stars of definite deviation of the continuous background from a black-body curve. Other classifications of A stars are briefly discussed. M. A. E.

2780. Velocities of B-type Stars. J. Schilt. *Nat. Acad. Sci., Proc.* 16. *pp.* 263–268, *April*, 1930.

For Plaskett's formula [see Abstract 2487 (1930)], the author takes $v = V_1 \cos(l - l_1) + K + rA \sin 2(l - l_0) \cos^2 b$, confining himself to the sun's motion perpendicular to the galactic plane. Galactic longitudes have great weight in B-type stars on which the apical declinations chiefly depend, but in the B subdivisions these may vary from 0° to 60°; this is

explained by the fact that the bulk of bright B stars are contained in four or five star clouds, each cloud having its group velocity, so that the various determinations based upon them may differ and the K term be different from zero; it might be negative if the sun occupied a place beyond the Orion group. To obtain a more stable solution for the solar motion, more families and therefore fainter stars must be included, and the K-term may tend to zero for these fainter groups. Plaskett got this conclusion, but the author objects to his method, for he takes the sun's velocity for granted, on which the K and A values depend. The author solves Plaskett's table for B_3–B_5 stars, but finds no second-order term, the modified solar motion representing it better. This negative result is against Lindblad and Oort's rotation theory, and the author concludes that the presence or absence of a second-harmonic term is due to a mixture of stars belonging to different streams. A. S. D. M.

2781. Spectroscopic Parallaxes of B-type Stars (Sixth Paper): Spectral Types and Parallaxes of 175 Stars. D. L. Edwards. *Roy. Astron. Soc., M.N.* 90. *pp.* 523-534, *March,* 1930.

The scale is such that the distance between Hβ and Hδ is 21·4 mm. Ilford "Iso-zenith" (speed 700 H and D) and Imperial "Eclipse Spot" (speed 850) plates are used; the region investigated is λ4481 to λ3933. The spectral types were determined from measurements of intensities of the principal lines of He, H, C, O, Si, Mg and Ca. Tables give the final results of 175 stars; the spectral classifications, absolute magnitudes and parallaxes as determined elsewhere for comparison; the mean values of the parallaxes from different sources; and the frequency distribution of line-character groups. It is noted that Struve finds a good correlation between his results and those found by spectroscopic methods at Mt. Wilson and Sidmouth. [See Abstract 1534 (1928)]. A. S. D. M.

2782. X-Rays in the Stars. A. S. Eddington. *Brit. J. of Radiology,* 3. *pp.* 99-111, *March,* 1930.

Discusses stellar temperatures. The electronic systems of the atoms are stripped from the atomic nuclei at the high temperatures which appertain (5 to 40 million degrees). X-rays are present within the stars, but, owing to the repeated conversion of radiation and ionic energy, only a minute proportion of energy is radiated in the form of heat and light. By means of mass-luminosity curves the mass of stars can be determined and it is found that, whereas some stars have a volume much greater than their mass would indicate, others have a very great mass with respect to volume (in one case a density 3000 times that of platinum). The explanation is in terms of the greater degree of compressibility of matter when the outer electronic rings of the atom are removed. B. J. L.

2783. Theory of Absorption Lines in Stellar Atmospheres. V. Ambarzumian. *Zeits. f. Physik,* 61. 1-2. *pp.* 151–152, 1930.

A dependence is derived between the intensity within a spectral line and other physical quantities in the stellar atmosphere [see Abstract 2476 (1930)]. If τ is the ratio of the intensity in the centre of the stellar layer emitting the beam to that of the continuous spectrum, the author finds the integral equation:

$$k_\nu \tau^{1/n}(1 + k_\nu \tau^{1/n})^{-1} = \phi_\nu(\tau) - \{2(1 + k_\nu \tau^{1/n})\}^{-1} \int_0^\infty \mathrm{Ei}|\tau - t|\phi_\nu(t)\,dt,$$

where $k_\gamma^n = (\epsilon 1 \rightarrow 2)^n (\mathrm{B1} \rightarrow 2\mathrm{P}_\gamma)^{-n} (q_\gamma \epsilon g)^{-1}$, but there are great difficulties in its calculation. A. S. D. M.

2784. Mean Light-Curves of Long-Period Variable Stars. A. A. Nijland. *K. Akad. Amsterdam, Proc.* 33. 2. *pp.* 112–118, 1930.

In 1904 at the Observatory of Utrecht regular observations of long-period variables were begun, and are still in progress. From 674 observations of W. Herculis, it appears that its period is 279 days, the mean maximum is $8^{\mathrm{m}}\cdot 21$ and mean minimum $13^{\mathrm{m}}\cdot 50$. The deviations from mean maximum seem to occur quite irregularly, and are much more marked than the deviations from mean minimum. The mean curve, derived from 32 observed, is perfectly smooth. M. A. E.

2785. Velocity Ellipsoid, Galactic Rotation and Stellar System Dimensions. B. Lindblad. *Roy. Astron. Soc., M.N.* 90. *pp.* 503-516, *March,* 1930.

A study of the effect of differential rotation and of the velocity ellipsoid for the same groups of stars (B0–B7, B8–B9, types A, and F–K, these later types being each subdivided into three proper motion classes). Tables are given: for the more distant groups, of differential rotation confirming the value $l_0 = 332^\circ \pm 5^\circ$ in fair agreement with the galactic centre, $l = 325$, derived from globular clusters, faint stars and the asymmetrical drift of high stellar velocities; and for velocity ellipsoids, where the B stars show a tendency to form vast local clusters, but the F–K group I gives good agreement with theory. The deviations of the observed velocity surface from the theoretical one are correlated with one another and reach a definite maximum in the A type due to the Ursa Major Stream. The value of the differential galactic rotation (A), expressed in seconds of arc, is $+ 0''\cdot 0032$, of the angular speed of rotation around the system's centre at our distance (6500 parsecs) from it is $+ 0''\cdot 0088$, and the mean proper motion in galactic longitude (B) is $0''\cdot 0057$; the period of revolution is 150 million years, and the total mass is of the order 11×10^{10} solar masses. The author criticises Mineur's suggestions. [See Abstract 3300 (1929) and following Abstract.] A. S. D. M.

2786. Galactic Rotation. H. Mineur. *Roy. Astron. Soc., M.N.* 90. *pp.* 516–523, *March,* 1930.

A summary of the author's results [see Abstracts 3300 (1929) and 2114 (1930).] He urges that there is an alternative centre of rotation to $G_0 = 330^\circ$ (which is near the galactic centre longitude, 325°) in $G_0 = 240^\circ$ (which is near the local cluster centre longitude, 243°). He makes a statistical study of G_0; a general study of the radial velocities of the stars; another of Dyson's investigation of the B and A stars in Boss's catalogue; and one on the apex. He points out that most of the groups, considered by Stromberg, showing the asymmetrical drift are outside the local cluster. From dynamical considerations he finds that the movements of the nearest stars are composed of two rotations, one round the centre of the local cloud, which in its turn rotates round the centre of the galaxy, a movement not unlike that of the moon in the solar system.
A. S. D. M.

LIGHT.

2787. Absorption of Light by Chlorine, Bromine and their Gas Mixtures. L. T. M. Gray and D. W. G. Style. *Roy. Soc., Proc.* 126. *pp.* 603–612, *March* 3, 1930.

Quartz cells filled with pure halogen gases have been considered preferable to filters containing organic compounds, but Allmand and Weigert [see Abstract 1940 (1926)] independently observed that the absorption by chlorine changed with the intensity of the beam. Repeating the experiments of Weigert and Nicolai [*Zeits. phys. Chem.* 131. p. 267, 1928] by the thermopile galvanometer and photographic methods, the authors find no intensity effect and confirm the extinction coefficients of Halban and Siedentopf [see Abstract 895 (1923)]. They also measure the extinction coefficient of bromine vapour for the chief lines of the quartz-mercury arc. In mixtures of bromine and chlorine a decrease of the absorption with time was observed for short waves, up to about 300 $\mu\mu$, but not for the longer waves 546 and 579 $\mu\mu$. This effect may be due to the formation and decomposition by light in such mixtures of the compound BrCl [see Barratt and Stein, Abstract 2022 (1929)]; but there may be other changes, and the mechanism is not clear. H. B.

2788. Spectro-Colorimeter for Studying Influence of Time on Apparent Saturation of Colours. H. Piéron. *Rev. d'Optique*, 9. *pp.* 5–16, *Jan.*, 1930.

The instrument is arranged so that two surfaces may be compared, the light falling on them being variable in intensity and colour; the light on one may be replaced for a controlled period by a white light. Thus, the influence of the period of stimulation on the perception of colour can be studied. The preliminary results indicate that the saturation observed has a latent period, and then passes through a maximum. J. H. A.

2789. Photodichroism and Photoanisotropy. Part VI. F. Weigert and M. Nakashima. *Zeits. f. phys. Chem.* 7. *Abt. B.*1. *pp.* 25–69, *March*, 1930.

Examines, by the dichrometric methods used in the same manner as previously described for the photochlorides and dyes [see Abstracts 115–117 (1930)], the colour adaptation of gelatin layers containing the visual purple of frogs. The photodichroitic effects are found to be the same as those obtained for systems previously examined, the dichrometric colour adaptation being extremely sharp. A striking instability of the photodichrometric adaptation curves is observed, which is different from previously observed results for other materials. The form of these curves changes after several hours to a new form which corresponds to the absorption spectrum of the visual purple. Only layers treated with the visual purple of summer frogs show normal effects, whilst those with the visual purple of winter frogs and fish possess similar anomalous peculiarities. The new results are compared with the known characteristics of visual purple. Finally, the numerous striking anomalies existing between the optical peculiarities of visual purple described and colour vision are discussed. It is here that the experimental basis of a new theory of

colour vision is to be found, which is termed an " adaptation theory of colour vision " to distinguish it from existing theories. R. C. F.

2790. Reflection Factor of Magnesium Oxide. J. S. Preston. *Optical Soc., Trans.* 31. 1. *pp.* 15–35, 1929–1930.

The design and use of a small integrating reflectometer for determining the total reflection factor of a smoked magnesium oxide surface under diffuse illumination are described. It is also shown how the reflectometer may be used for the absolute determination of apparent reflection factors under parallel illumination. The instrument is based on theory given by A. H. Taylor [see Abstract 1399 (1920)], and this theory is extended to show how the interior of a small integrating sphere may be used as a standard of brightness when the diffuse reflection factor of the coating and the flux entering the sphere are known. A second method of determining the diffuse reflection factor of the reflectometer is also described. It was found that the surface on which the oxide is smoked may influence results, and polished silver was finally selected, and the results given are for coatings on this surface. The apparent factors at normal and 45° angle of view and diffuse illumination from polar measurements of brightness under conditions of parallel illumination are calculated by means of the Helmholtz reciprocal relations. J. G. H. B.

2791. Dispersion and Reflection of Light by Dull Glasses. E. Flach. *Gerlands Beitr. z. Geophys.* 25. 3–4. *pp.* 290–326, 1930.

A problem in the theory of turbid media is considered, the dispersion of light by dull and turbid kinds of glass with varying degrees of diffusion and reflection, with reference also to meteorological methods of measurement of radiation. A potassium photoelectric cell was used for measuring the intensities of light which had traversed the glass or been reflected by it. The values found in the case of the kinds of glass used in practice differ considerably from the data given by the " photometric fundamental law " according to the turbidity of the glass. The practical and theoretical investigations carried out up to the present are discussed and new relations between the intensities of light which has passed through turbid glass and the relative thickness of strata are given. Two kinds of apparatus for the measurement of the light passing through or reflected from the glass are described. A special form of photo cell exhibited the diffraction effect due to the lattice action of the separate particles in a turbid or dull glass. The supposition that light from different regions of the spectrum was differently diffused by the dull glasses was not confirmed. The results of measurement in separate cases are discussed. The results as affecting meteorological measurements of radiation are considered, especially the case of the determination of the so-called " local clearness." It is concluded that the measurements can only be compared if the permeability for light of the glass and the diffusing and reflecting action as well as the distribution of brightness in the sky are known. The latter depends on a relation to the zenith distance and the azimuth, which is not a simple one. J. J. S.

2792. Calculation of Unknown Refractive Indices of the Refractometer Prism from Known Values. A. Karvonen. *Zeits. f. Instrumentenk.* 50. *pp.* 185–189, *March*, 1930.

Using hydrogen lines of known wave-length the constants in the Hartmann dispersion formula were obtained by successive approximations.

Using these values refractive indices were obtained for three hydrogen and two mercury lines, and one of sodium, and these agreed with known values to 1×10^{-5}. Values were next calculated for other He, Hg and Li lines. Practical proof of the formula was given by obtaining refractive indices for water with a Pulfrich refractometer. Special precautions were taken to avoid errors in measuring the temperature of the water. Values over the wave-lengths 3440–7065 Å. were obtained and compared with the mean of earlier values. Except for H_γ and H_β, where the values found are slightly lower than earlier values, the agreement is almost complete.

R. S. R.

2793. Anomalous Dispersion of Polar Solutions. R. Goldammer and H. Sack. *Phys. Zeits.* 31. *pp.* 224–227, *March* 1, 1930.

The assumption that the orientation of electric dipoles in solid connection with the molecule in an external field contributes to the electric polarisation of a medium, conditions the existence of a dispersion phenomenon the frequency region of which may be distinctly different from the optical dispersion (Debye, *Polare Molekeln*, 1929). The relaxation time required for the adjustment of the dipoles in the field, and, hence, for the position of the dispersion region, is given by $\tau = \zeta/2k\mathrm{T}$, where k is the Boltzmann constant, T the absolute temperature, and ζ the friction experienced by a molecule on rotation. An attempt is made to compare this frictional force with the viscosity measured macroscopically. For bromonaphthalene in vaseline this viscosity is about 1000 times as great as that corresponding with the measured dispersion, owing to the fact that the molecules are still able to rotate between the very viscous masses of vaseline. Good qualitative agreement with the theory is obtained with mixtures of isobutyl alcohol and paraffin oil. T. H. P.

2794. Paramagnetic Rotatory Dispersion of Aqueous Cobalt Sulphate. R. W. Roberts. *Phil. Mag.* 9. *pp.* 361–390, *March*, 1930.

Ladenburg has shown that paramagnetic atoms can give rise to negative magnetic rotations and has given a quantum formula, which has been verified by Becquerel and de Haas for crystals containing rare earth metals. In the present paper experiments which have established the negative rotations produced by Fe^{++}, Fe^{+++} and Co^{++} have been extended by measuring the magnetic rotations of five solutions of cobalt sulphate in the visible and ultra-violet regions from 6908 to 2482 Å. The rotations of the salt are negative in the red and ultra-violet, but become positive in the yellow and green region on approaching the absorption-band at 5100 Å. The refractive indices of the solutions were also measured from 7065 to 2378 Å., and values were deduced for the molecular refraction of the dissolved salt. The characteristic frequencies of the electrons were calculated as follows:

$$\nu_1^2 = 6{\cdot}14(\lambda_1 = 1217\ \text{Å.}),\ \nu_2^2 = 112{\cdot}6(\lambda_2 = 283\ \text{Å.}),\ \text{and}\ \lambda_0 = 5100\ \text{Å.}$$

Ladenburg's formula for magnetic rotatory dispersion was then used to deduce: (i) the frequency of the ultra-violet paramagnetic band; (ii) the number of electrons per molecule causing the band at 5100 Å., and the moment of this band. T. M. L.

2795. Magnetic Field of the Large Bellevue Electromagnet and Magnetic Birefringence. A. Cotton and G. Dupouy. *Comptes Rendus*, 190. 544–547, *March* 3, *and pp.* 602–606, *March* 10, 1930.

Graphs are given mapping the topography of the fields produced

between various sizes of pole-pieces when the electromagnet [see Abstract 3304 (1928)] carries 400 amperes at 230 volts. The fields are specified for points in an equatorial line across the lines of force, and in one instance a maximum field of 60 kilogauss is recorded. An account is given of the precautions and adjustments employed in applying the large electromagnet to the measurement of magnetic double refraction in pure nitrobenzene, which gives, in a 32-cm. tube, for the green light of a mercury lamp a rotation of over 27°. [See also following Abstract.] G. E. A.

2796. Magnetic Birefringence of Ethylic Alcohol, Water and Aqueous Solutions of Nitrates. M. A. Haque. *Comptes Rendus*, 190. *pp.* 789–790, *March* 31, 1930.

An account of measurements made on alcohol, water and nitrates of sodium and ammonia by the aid of the large Bellevue magnet [see preceding Abstract]. The values found are compared with those of Ramanadham. [See Abstracts 121 and 572 (1930).] **Errata,** *ibid.* p. 1344, June 11, 1930. G. E. A.

2797. Magnetic Birefringence of Para-Azoxyanisole at Temperatures above the Point of Disappearance of the Mesomorphic State. Jacqueline Zadoc-Kahn. *Comptes Rendus*, 190. *pp.* 672–674, *March* 17, 1930.

The magnetic birefringence above the transformation point at 133° C. in liquid para-azoxyanisole (melting point 116° C.) is considerably stronger than that of ordinary liquids, and varies rapidly with temperature, especially as the transformation temperature is approached. The hyperbolic curve representing the variation of the magnetic birefringence with temperature is closely analogous to that connecting temperature and magnetisation of ferromagnetic substances above the Curie point. A. J. M.

2798. Magnetic Birefringence of Oil Samples of Various Origins. A. Cotton and M. Scherer. *Comptes Rendus*, 190. *pp.* 700–702, *March* 24, 1930.

Tests carried out upon six different samples of purified oils showed definite differences in the magnetic birefringence in the yellow, green and indigo. Using the formula $\beta/\pi = C_m \int H^2 \, . \, dl$, values were obtained for the constant C_m, which gives the magnetic birefringence for unit field in a sample of unit thickness. In tables the values of β, d (density) and $(C_m/d)\ 10^{14}$ were given. The author considers this method can be applied to other samples, and from the magnetic birefringence values the samples can be quickly classified for their richness in aromatic compounds. R. S. R.

2799. Magnetic Birefringence of Organic Substances Liquefied by Fusion. C. Salceanu. *Comptes Rendus*, 190. *pp.* 737–739, *March* 24, 1930.

The magnetic birefringence, β, of fused β-methylnaphthalene, for $\lambda = 578\ \mu\mu$, varies from $4 \cdot 75°$ at $36 \cdot 5°$ C. to $3 \cdot 84°$ at 89° C., or, compared with that of nitrobenzene at 20° C., from $+1 \cdot 002$ to $+0 \cdot 810$. Cotton and Mouton's constant C has the value $2 \cdot 465 \times 10^{-12}$ at $36 \cdot 5°$ C. The value of β at 62° C. varies from $4 \cdot 27°$ for $\lambda = 578\ \mu\mu$ to $6 \cdot 15°$ for $\lambda = 436\ \mu\mu$, the variation with the wave-length being slightly less in amount than for nitrobenzene. T. H. P.

2800. Errors of Registration in the Microscope with Microscope Eyepiece Measurements. W. Felgenträger. *Zeits. f. Instrumentenk.* 50. *pp.* 189–192, *March*, 1930.

Consideration is given to errors which may arise in consequence of the

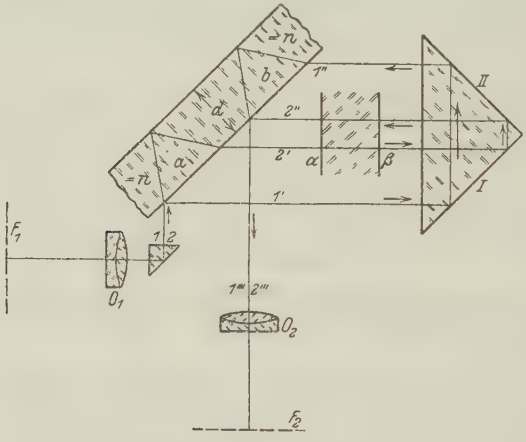
plane of the object being different from that of the scale in the eyepiece. Tests were made with five different eyepieces. Equations are given to determine the magnification, and the possible errors are stated. R. S. R.

2801. Spectral Intensity and Groove Form of the Diffraction Grating. Jenny E. Rosenthal. *J.O.S.A.* 20. *pp.* 87-96, *March*, 1930.

Starting with the known formula of the amplitude of the light diffracted by one face, an expression is obtained for the intensity due to one triangular groove. A discussion of this expression gives the direction of the maximum of kth order. A condition is also found which leads to concentration into a few spectra, an easily realised case being normal incidence on a groove with equal sides. A circular groove is then discussed, the arc being taken as a regular polygon of n infinitesimal sides. F. S.

2802. New Form of Jamin Interference Refractometer. F. F. Martens. *Zeits. f. Physik*, 61. 5-6. *pp.* 363–367, 1930.

Substitutes a right-angled prism for the second plane-parallel plate,



as shown in the diagram. This reduces the length of the apparatus to one-half with equal sensitiveness and reduces the effect of concussion. The apparatus is useful not only for the measurement of refractive indices, but also for the exploration of sound fields. E. E. F. d'A.

2803. Photographic Chemistry. Part I. T. Suzuki. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers*, No. 229. *pp.* 285-293, *March* 15, 1930. *In English.*

Examines the dispersion of silver halides through aqueous media. It is shown that there are many widely different classes of substances which cause this dispersion and a minimum quantity of each of these substances appears to be necessary to disperse a definite quantity of silver bromide. The dispersion is a disintegration only and not a formation of new grains, and the suspensoids thus formed are not permanent, as the grains settle on standing. Acids and alkalis all break down the suspensoids, as do some types of salts. Silver bromide precipitate is well dispersed by all sensitisers and desensitisers of silver bromide plates, but this is not the complete condition, as there are many substances, including colouring matters, which do not possess either of these properties and yet are good dispersive materials. The colours of suspensoids made by using colour

sensitisers are unstable to light, whilst those of suspensoids made by desensitisers are quite stable. These silver bromide grains made by dispersion are able to take light impressions which can afterwards be developed out. Other silver halides and precipitated mercurous and thallous chlorides also show the above phenomena. R. C. F.

2804. Solarised Latent Image of Photographic Emulsions. A. P. H. Trivelli. *Frank Inst. J.* 209. *pp.* 373-389, *March*, 1930. *Kodak Research Lab. Comm. No.* 416.

Discusses the main theories which have been advanced to explain solarisation as a development and as a latent image problem. The two most important theories, those of the progression theory of coagulation of the latent image silver by prolonged exposures and the regression theory, are critically examined, it being shown that the coagulation theory in its present state is not acceptable because it does not agree sufficiently with a number of phenomena which occur in solarisation. The regression theory in combination with the concentration speck theory is, however, qualitatively satisfactory, and a tentative hypothesis of the solarised latent image is given using this combination of theories. Finally, Lüppo-Cramer's explanation of solarisation is shown to hold for X-rays. R. C. F.

2805. Herschel Effect and Deviations from the Reciprocity Law. A. P. H. Trivelli and V. C. Hall. *Phot. Indust.* 28. *pp.* 284-286, *March* 5 ; 312-314, *March* 12 ; *and pp.* 336-338, *March* 19, 1930. *Comm. No.* 387 *from the Kodak Forschungs. Lab., Berlin.*

Experimentally examines the deviations from the reciprocity law for a pure silver bromide emulsion and for a high sensitivity silver bromo-iodide emulsion. It is shown that an infra-red illumination of the latent image, with three different intensities, produces three different grades of the Herschel effect. Leszynski [see Abstract 981 (1927)] was unable to obtain any signs of the Herschel effect if the first illumination was performed with low intensities. The present authors found, under these conditions, a marked Herschel effect, although accurate confirmation cannot yet be made. With decrease in intensity of the first illumination it is found that the position of the maximum Herschel effect shifts towards the lower densities. The degree of bleaching produced by the red illumination of parts with the same density after development can be found by interpolation, even though they have been illuminated first by different intensities of white light and afterwards by the same intensity of red light. The deviations from the reciprocity law are affected by time if the latent image formed by different intensities of white light is exposed to red illumination. R. C. F.

2806. Photomicrography of Silver Halide Grains with Ultra-Violet Radiations. A. P. H. Trivelli and R. P. Loveland. *J.O.S.A.* 20. *pp.* 97–105, *March*, 1930. *Kodak Research Lab. Comm. No.* 424.

Mees [see Abstract 2074 (1926)] has suggested that the mercury line 3650 Å. and a glass system are particularly suited to photomicrography with ultra-violet radiations, and that the slight gain in resolution obtained with a quartz system and a mercury arc over that obtained with the above may not justify the added cost. These conclusions are shown to be correct from comparative photomicrograms taken with the two systems. A new method of focussing which utilises visible radiation is described. The image is focussed first by blue or violet radiation on the ground glass and then photographed with the ultra-violet radiation. The

image obtained is out of focus, so that for the visible light the image on the ground-glass screen must be thrown out of focus in the opposite direction by the same amount for correct focussing with ultra-violet radiation The same method is applicable the near infra-red photomicrography.

R. C. F.

2807. Composition of the Ca-Sr-Sm-Sulphide-Mixed Phosphors. E. Rumpf and M. Travniček. *Ann. d. Physik*, 4. 6. *pp.* 725-732, *March* 26, 1930.

Shows that in the preparation of the Ca-Sr-Sm-S-mixed phosphors, mixed crystals of the Ca-Sr-F-series with a large strontium content are formed. The sulphide concentration of such a phosphor obtained is not identical with the concentration of the sulphide-mixed crystals frequently developed. It is presumed and also confirmed that the pure Ca-Sr-S-mixed crystal series satisfies the Vegard additivity law. The Ca-Sr-concentration obtained does not determine the position of the phosphorescence bands of the mixed phosphors. This position is determined by the usual grating constant of the sulphide-mixed crystals, and a linear connection is obtained between the wave number of the phosphorescence and this grating constant. No phenomena due to ageing can be observed. [See also Abstract 911 (1928).] R. C. F.

2808. Thallium-Containing Alkali-Halide Phosphors. W. v. Meyeren. *Zeits. f. Physik*, 61. 5-6. *pp.* 321–331, 1930.

The distribution of intensity in the light emitted by certain thallium-containing alkali-halide phosphors is investigated by the method of photographic photometry. The phosphorescence was excited by monochromatic light, and emission bands were observed having maxima at a wave-length less than 430 $m\mu$. The emission is identical for fluorescence and for phosphorescence, and it is independent of the wave-length of the exciting light. The most simple distribution of emission intensity occurred in the NaCl and KCl phosphors. In the temperature interval — 180° to 150° they gave only one single emission band. An experiment was made to examine the effect of exciting with kathode rays, with a view to investigating the Schumann region. A. C. M.

2809. Reversible Oxidation in Luminescence. E. L. Nichols. *J.O.S.A.* 20. *pp.* 106-114, *March*, 1930.

Shows that luminescence excitation by suitable radiations is a process which frees oxygen, sometimes in the active form, from certain easily reducible substances. Free oxygen produces luminescence, with excitation, when supplied from an external source to easily oxidisable substances previously reduced by chemical means. Removal of the free oxygen produced by radiation is found to stop the formation of luminescence. Cando-luminescence, or luminescence at high temperatures, is due to reduction, possibly by active hydrogen, and immediate re-oxidation due, presumably, to the active oxygen in the flame. This cando-luminescence also possesses all the characteristics common to luminescence at room-temperature. This indication of a common origin in the two cases leads to the conclusion that luminescence is the result of reduction followed by oxidation under conditions which make this a light-emitting reaction.

R. C. F.

2810. Activators in Cando-Luminescence. E. L. Nichols and L. J. Boardman. *J.O.S.A.* 20. *pp.* 115–130, *March*, 1930.

Traces of certain substances render solids fluorescent. The same sub-

stances (*e.g.*, oxides of Cu, Mn, Cr and the rare earths) are effective in greatly increasing the luminescence of incandescent oxides. In this phenomenon also, the activator must be in solid solution, enhancement increases as the proportion of activator decreases down to a definite optimum, no known solid responds to all activators, and no known activator is effective with all solids capable of luminescence. Further, where several activators are present, one tends to dominate the rest. In cando-luminescence enhancement rises to a maximum at a definite temperature characteristic of the activator and independent of the solvent.

A. C. M.

2811. Measurements of Thermoluminescence of Glass Exposed to Light. R. E. Nyswander and B. E. Cohn. *J.O.S.A.* 20. *pp.* 131–136, *March*, 1930.

Glass turned violet in colour due to long exposure to sunlight is thermoluminiscent when heated to temperatures above 100° C. Thermoluminescence was also observed in some samples free from colour, while others showed no luminescence. Effects similar to those for sunlight were also observed from glasses exposed to the carbon or mercury arc, and in some cases for exposures of only a few minutes. Special glasses were made from a chemically pure zinc-borate glass to which was added a trace of one of the following metals: barium, calcium, strontium, magnesium, manganese, aluminium, nickel, cobalt, chromium, silver, cerium, thallium and thorium. Each of the above was exposed to sunlight and tested for thermoluminescence, the most intensely luminescent being thorium, cerium, silver, chromium, cobalt and manganese. The following curves were determined: growth of luminescence with time of exposure, both for sunlight and the carbon arc; effect of concentration of solute; decay of thermoluminescence and periodic changes of luminescence as dependent upon time after excitation. All light measurements were made with a polarisation photometer.

AUTHORS.

2812. Fluorescence of Praseodymium and Neodymium Glass. P. Pringsheim and S. Schlivitch. *Zeits. f. Physik*, 61. 5–6. *pp.* 297–306, 1930.

The discontinuity of the fluorescence spectra of glasses containing praseodymium, neodymium and didymium does not depend on discontinuity in the absorption spectrum but upon the emission process. Praseodymium glass shows many independent band groups which have different intensities in various samples of glass. The fluorescence of neodymium glass is much weaker, but many didymium glasses show very strong fluorescence of the neodymium type. The intensity with all such glasses depends largely upon their composition.

F. S.

2813. Absorption Spectra of Methyl Halides and other Methyl Compounds in the Ultra-Violet and Schumann Regions. G. Herzberg and G. Scheibe. *Zeits. f. phys. Chem.* 7. *Abt. B.* 5. *pp.* 390–406, 1930.

Examines the ultra-violet absorption spectra, down to approximately 1500 Å., of methyl halides, CH_3OH, CH_3CN and C_2H_5OH, all of which are used in the gaseous state. The results for the longer wave-lengths show a fairly extended continuous spectrum corresponding to the splitting up of the molecule into the methyl and halogen parts. This is in contradistinction to the results of Henri and others. Methyl halides particularly

show discontinuous bands in the shorter wave-lengths, and for CH_3I they are very extended and sharp. A simple law is obtained for the principal bands. At least four widely separated groups can be distinguished with a separation of approximately 5000 cm.$^{-1}$, these representing probable changes of the molecule from the basic condition through a series of differently excited electronic states. There is also a frequency difference of 1080–1090 cm.$^{-1}$ between the principal band and the first band, due to the excited electronic states. This value is obtained for CH_3Br, although the bands are very diffuse owing to overlapping of the continuous section. This is especially noticeable in the case of CH_3Cl. No discontinuous bands are obtained for the CH_3OH, CH_3CN and C_2H_5OH vapours. [See also Abstract 655 (1930).] R. C. F.

2814. Ultra-Violet Absorption Spectrum of Aniline Vapour. J. Savard. *Comptes Rendus*, 190. pp. 678-681, *March* 17, 1930.

The equations for the bands in the ultra-violet absorption spectrum of the vapour are determined. The spectrum of aniline shows that the values of the characteristic constants of the aniline molecule are quite comparable with those of other benzene derivatives. The deformability of the aniline molecule is also comparable, as regards order of magnitude, with that of the other benzene derivatives. The NH_2 group, however, produces a much more marked lowering of the energy of activation of the benzene molecule than other substituents. Below 2813 Å. an abrupt modification of the electronic state of the aniline molecule occurs to which corresponds an energy of activation of 101·545 cal.-mol.-gm. Aniline is the only benzene derivative examined, the spectrum of which shows a zone of continuous absorption corresponding to a dissociation or ionisation of the molecule. The heats of combustion of benzene, toluene, phenol and aniline show a proportionality related numerically to the constants of their spectra. A. J. M.

2815. Infra-Red Absorption Spectra of Some Organic Liquids. E. K. Plyler and T. Burdine. *Phys. Rev.* 35. *pp.* 605-612, *March* 15, 1930.

The infra-red absorption spectra of 14 organic compounds, including 7 alcohols and 7 miscellaneous compounds, have been studied in the region from 1 μ to 7·5 μ. The bands in the region from 1 μ to 3 μ have been classified as overtones or combination bands of the assumed fundamental bands for the alcohols at about 3·00 μ, 3·4 μ, 6·8 μ and 9·8 μ. By the use of Sappenfield's work for the region from 1 μ to 2 μ and that of Weniger from 7·5 μ to 10 μ and the present work a fairly complete idea of the infra-red absorption spectra of the alcohols has been obtained. The intensity relations have been discussed briefly, and it was shown that they were in general in accordance with combinations attributed to the different bands. The bands of the miscellaneous organic compounds have been classified, but all the bands have not been included, as only the fundamentals at 3·4 μ and 6·8 μ were used. A probable reason for the similarity of the infra-red spectra of many organic compounds in the region from 1 μ to 3 μ has been suggested. AUTHORS.

2816. Near Infra-Red Spectra of Helium and Mercury. T. Takamine and T. Suga. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 232. [6 *pp.*], *March* 20, 1930. *In English.*

Repeats previously published work [see Abstract 181 (1930)], using a

larger dispersion spectrograph and improved methods of controlling the heating of the plates. This heating definitely improves the results, especially for the region above 9000 Å. The helium spectrum, although considerably improved as regards dispersion, is still not long enough to allow of accurate measurements for the analysis of the helium band. Numerous neon lines are also recorded. In the mercury arc spectrum (Hg.I) two groups of lines, apparently falling into series of the form $\nu = x - m^3S$ and $\nu = x - m^3D$, are observed. The final term "x" is an unknown energy level, having a value of 15,229 cm.$^{-1}$ and probably of the nature of a P– term common to both series. R. C. F.

2817. Band Spectrum of Diatomic Carbon Vapour. K. Kopfermann and H. Schweitzer. *Zeits. f. Physik*, 61. 1-2. *pp.* 87-94, 1930.

The band system discovered by Deslandres and d'Azambuja has been excited with greater intensity in a vacuum carbon arc, and the fine structure investigated with both prism and grating spectrographs. Tables of results are given. The results are explained by a $'\pi \rightarrow {}'\pi$ electron jump in the C_2 molecule. F. S.

2818. Band Spectra of Cadmium and Bismuth. S. Barratt and A. R. Bonar. *Phil. Mag.* 9. *pp.* 519-524, *March*, 1930.

Walter and Barratt [see Abstract 1565 (1929)] have shown that five of the seven bands attributed to the cadmium molecule by Mohler and Moore [see Abstract 92 (1928)] are due to impurities and not to the metal itself. Of these five groups III, IV and V, lying between 3018 Å. and 3181 Å., can be attributed to a compound of cadmium and chlorine, whilst groups VI and VII, between 3182 Å. and 3328 Å., are attributed to thallous chloride. In the present paper group II (2644 Å. to 2856 Å.) is shown to be due to bismuth instead of the cadmium molecule, and by making certain assumptions as to the nature of the bismuth molecule, its heat of formation is estimated to be 18·5 kg. cal. per gm. mol. or 0·80 volt. R. C. F.

2819. Spectrographic Determination of Cadmium, Lead and Iron in Zinc. D. M. Smith. *Faraday Soc., Trans.* 26. *pp.* 101-118, *March*, 1930.

The application of simple spectrographic methods to the determination of small quantities of impurities in zinc has been studied. Both arc and spark methods have been used; and their merits are compared. Simple and reliable methods of estimating cadmium, lead and iron in zinc have been developed. While both arc and spark methods are applicable, the former is recommended on account of its greater sensitivity in the case of lead. It is believed that the spectrographic method gives more concordant results, when the impurities to be estimated are present only to the extent of a few tenths per cent., than the ordinary methods of chemical assay. It has the further advantage of being a comparatively rapid method. F. J. W.

2820. Raman Spectra of Nitrates in Solution. I. Kishi. *Kyoto Coll. Sci., Mem.* 13. *pp.* 163-167, *March*, 1930. *In English.*

Mercury light is scattered in a bulb of the liquid, and the scattered light is condensed on to the slit of the spectrograph. Nitric acid and the nitrates in solution of Na, K, NM_4, Cd, Pb, Ba, Hg, Ca and Sr are investigated. Lines corresponding to shifts of 1042 cm.$^{-1}$ are found in all cases; and lines corresponding to 700 cm.$^{-1}$ in several cases. [See also Abstract 512 (1929).] A. C. M.

2821. Intensities of Multipole Lines in the Balmer Series. J. Blaton. *Zeits. f. Phisyk*, 61. 3–4. *pp.* 263–273, 1930.

The selection rules of quantum mechanics follow on the assumption of dipole radiation from the atom. When the actual Schrödinger charge distribution and the retarded potentials are employed, however, the forbidden lines may have a small but finite intensity. Expressions for the intensities of the so-called multipole lines are worked out for the case of an electron in a central field. The results are applied to the Balmer series of hydrogen, the relative intensities of the dipole and quadripole lines being given in the following table:

Transition.		$l = 3$.	$l = 4$.	$l = 5$.
Quadripole Lines	$l_2 - 2_0$	$176 \cdot 10^{-13}$	$24 \cdot 10^{-13}$	$5 \cdot 10^{-13}$
	$l_3 - 2_1$	—	$1615 \cdot 10^{-13}$	$1209 \cdot 10^{-13}$
	$l_1 - 2_1$	$198 \cdot 10^{-13}$	$115 \cdot 10^{-13}$	$66 \cdot 10^{-13}$
Dipole Lines ..	$l_1 - 2_0$	$182 \cdot 10^{-7}$	$105 \cdot 10^{-7}$	$9 \cdot 10^{-7}$
	$l_2 - 2_1$	$874 \cdot 10^{-7}$	$376 \cdot 10^{-7}$	$193 \cdot 10^{-7}$

W. S. S.

2822. Spark Spectrum of Argon. Part III. T. L. de Bruin. *Zeits. f. Physik*, 61. 5–6. *pp.* 307-320, 1930.

New measurements of the spectrum have been undertaken, which agree well with the recently published results of Rosenthal. These are chiefly used in this paper, since Rosenthal employed greater dispersion than the author. For the explanation of the spectrum in the extreme ultra-violet the measurements of Compton, Boyce and Russell [see Abstract 150 (1929)] were employed, and their interpretation of these lines is extended and corrected. To the 180 lines classified in Part II [see Abstract 488. (1929)] 360 are here added and classified. The published Zeeman effects for argon, and some material which has not yet been published, formed the starting-point for a large number of new terms, which take their place easily in the theoretical schemes. The paper contains term tables and tables of the classified AII lines. [See also following Abstract.] H. N. A.

2823. Structure of the Spectrum of Ionised Argon (AII). T. L. de Bruin. *K. Akad. Amsterdam, Proc.* 33. 2. *pp.* 198–212, 1930. *In English.*

This is in the main identical with a recent paper by the author [see preceding Abstract]; but it contains, in addition, a diagram showing the relation between the energy levels in the ionised argon atom. Very interesting data have been obtained for the theory of series limits and inverted and non-inverted terms. Only three lines of the extreme violet spectrum have not been explained. H. N. A.

2824. Second Spectrum of Xenon between 9000 and 6000 Å. G. Déjardin. *Comptes Rendus*, 190. *pp.* 580–582, *March* 3, 1930.

The spectrum was excited by an oscillatory discharge in an electrodeless tube. For the region 7000 to 5900 Å. a concave grating (150 cm. radius) and plates sensitised with pinacyanol were used; for 9000-7000 Å. a plane Rowland's grating and dicyanine sensitised plates. Accuracy varies from 0·05 to a few tenths Å. 135 lines attributed to XeII

were determined, together with about 120 of XeI, these latter agreeing well with the results of Meggers, etc. [See Abstract 1457 (1930).] C. A. S.

2825. Continuous Hydrogen Spectrum. D. Chalonge and N. T. Zé. *Comptes Rendus*, 190. *pp.* 632–634, *March* 10, 1930.

In continuation of previous work [see Abstract 1056 (1930)], the effect of change in the conditions of excitation has been investigated. The spectrum at 91 mm. pressure has been investigated with a current of 45 mA. at 9800 V and 206 mA. at 5800 V, and the intensity compared microphotometrically. Wood's observation of the catalytic action due to grinding the capillary is confirmed by a notable increase in intensity. The conclusions as to effect of pressure do not agree with those of Bay and Steiner [see Abstract 1860 (1930)]. F. S.

2826. Two Normal States of the NO Molecule. M. Lambrey. *Comptes Rendus*, 190. *pp.* 670–672, *March* 17, 1930.

The optical density of nitric oxide is proportional to $p^{1\cdot81}$ (where p is the pressure) for the γ bands, but to p for the β bands, providing spectroscopic verification of the existence of two different ^2P states of the NO molecule, both of which can be regarded as normal. A. J. M.

2827. Nuclear Spin and Hyperfine Structure. H. E. White. *Phys. Rev.* 35. *pp.* 441–444, *March* 1, 1930.

Assuming that hyperfine structure in spectral lines has its origin in the coupling of a nuclear spin with electron resultant J, a comparison between gross structure and hyperfine structure is made from the following relation, $\Delta\nu_g/\Delta\nu_f = m_k/4im_e$. For those atomic systems for which the electron configurations show LS or *jj* coupling, the agreement with the above equation is quite as good as would be expected. For electronic configurations which do not show LS or *jj* coupling it is doubtful whether such a comparison of gross structure with hyperfine structure can be suitably made. From the meagre data as yet available, one is led to suspect that nuclear spin is due to the last electrons, protons, or both (most probably electrons) added to the nucleus in atomic construction. These electrons should, in accordance with the principles of wave mechanics, have a *probability density* spherically symmetrical about the nucleus. The difference between the electrons associated with the nucleus and the outer electrons is that the nuclear electrons carry with them in space quantisation the total mass of the atom. Author.

2828. Effect of Hyperfine Structure Due to Nuclear Spin on Polarisation of Resonance Radiation. A. Ellett. *Phys. Rev.* 35. *pp.* 588–594, *March* 15, 1930.

Hyperfine structure must be taken into account in calculations of the polarisation of resonance radiation based upon Heisenberg's extension of the principle of spectroscopic stability. Where the hyperfine structures are due to the existence of a nuclear moment their effect upon the polarisation of resonance radiation may be calculated. If the nuclear moment of the thallium atom is $\frac{1}{2}$ (in units of $h/2\pi$) as Schüler and Brück suppose, the $\lambda\lambda$3776 and 5350 lines should show no polarisation, while λ2768 should show 33·3 to 35·1 % parallel and λ3530 41·8 to 48·8 % perpendicular to the electric vector of a plane polarised exciting beam. Sodium resonance radiation excited by plane polarised D_1 and D_2 lines should show 33·3 % polarisation if the nuclear moment is $\frac{1}{2}$ and 16·6 % if it is 1. The latter value agrees well with 16·3 observed by the writer, but observations on

band spectra seem to indicate a higher nuclear moment, according to F. W. Loomis and R. S. Mulliken. (Verbal communication to the writer.) AUTHOR.

2829. Second Spark Spectrum of Antimony. R. J. Lang. *Phys. Rev.* 35. *pp.* 445–451, *March* 1, 1930.

The vacuum spark spectrum from 6600–600 Å. and the Paschen hollow-kathode spectrum from 5200–1950 Å. have been measured, using vacuum grating and glass and quartz prism instruments. Tables of classified wave-lengths and of term values are given. Corresponding to the deepest term value an ionisation potential of 24·7 volts is calculated. A note on the SnII spectrum, similarly investigated, gives a number of wave-lengths and term values. F. S.

2830. Spark Spectra of Selenium and Tellurium. L. and E. Bloch. *Ann. de Physique*, 13. *pp.* 233-262, *March*, 1930.

The spectra were excited by an electrodeless discharge, which permits the separation of various orders of ionisation, and were photographed by prism and grating spectrographs between the limits 7246–2196 Å. The observed lines, including many new ones, are tabulated together with their allocation to SeII, SeIII, SeIV, TeII, TeIII and TeIV. F. S.

2831. Emission Spectrum of Benzene in the Region 2500–3000 Å. J. B. Austin and I. A. Black. *Phys. Rev.* 35. *pp.* 452–460, *March* 1, 1930.

The spectrum in benzene vapour was excited by means of a Tesla disachrge and photographed by two quartz spectrographs. The wave-lengths of over 100 bands were measured with an accuracy of $\pm$ 0·5 Å. and the results found to be in general agreement with those of McVicker, Marsh and Stewart. Equations are given which represent all but the faintest and most diffuse bands. The evidence that the bands are due to benzene and not to some decomposition product is summarised, good agreement being found with Henri's measurements of the absorption spectrum. F. S.

2832. Spectroscopic Evidence of Two Types of Ammonia Molecule. J. W. Ellis. *Phys. Rev.* 35. *pp.* 595-599, *March* 15, 1930.

A two-fold difference exists in the equations expressing the anharmonic frequencies arising from vibratory energy changes in ammonia molecules in solution and in gaseous form. The greater coefficient of the n^2 term in the former case, indicating a more rapid approach of the energy terms towards confluence, is assumed to arise from the proximity of the molecules of the solvent. The presence of a constant term of appreciable magnitude in the solution equation is interpreted as measuring the energy required to change the molecule from an α form to a β form of greater potential energy. Chemical support for this latter interpretation is sought in some earlier measurements by Baly and Duncan on the difference in the decomposition rates of ammonia both after immediate evaporation from the liquid and after it had stood for a considerable length of time. It becomes easier to interpret the Raman spectrum of liquid ammonia, ammonia in aqueous solution and a liquid organic derivative of ammonia, aniline, when the existence of a constant in the infra-red formula is recognised. AUTHOR.

2833. Afterglow in Air. J. Kaplan. *Phys. Rev.* 35. *pp.* 600-604, *March* 15, 1930.

It was observed that on passing a weak discharge through the air glow

the β bands of nitric oxide were very strongly excited. These bands possess several very interesting properties. They correspond to a transition from the B to the X level of the molecule, and the transition $B_0 - X_0$ is very improbable because of the large difference in nuclear separation. These bands have been obtained with considerable intensity only in active nitrogen. This present experiment is, therefore, the first one in which these bands have been observed with great intensity in an electric discharge. The β bands, as observed in the present experiments, correspond to transitions only from the B_0 to the various X vibrational levels, whereas in the afterglow of active nitrogen they correspond to transitions from several B levels to the various X levels. This difference indicates that there are at least two possible methods for exciting these unusual bands. They are excitation by recombination and excitation by collisions of the second kind. AUTHOR.

2834. Active Nitrogen. Part VII. Further Studies on the Decay of the Nitrogen Afterglow. E. J. B. Willey. *Chem. Soc., J. pp.* 336-349, *March* 1930.

Further work with improved technique [see Abstract 2191 (1929)] indicates that the decay of the nitrogen afterglow is partly homogeneous and partly heterogeneous, according to the conditions. Unless the walls of the containing vessels are " poisoned " by foreign gases, the recombination process is non-luminous and occurs as a surface reaction. As the concentration of the impurity rises, the wall reaction diminishes and the homogeneous decay increases, but above a limit of about 0·1 % the impurity reacts chemically with the active nitrogen and interferes with the normal decay. The order of the decay process is determined by the state of the walls, this depending on the purity of the nitrogen used. When the surface reaction is minimised, the effects of pressure and addition of other gases agree with the three-body recombination theory. The afterglow probably originates in a reaction $N + N' \rightarrow N_2'$; $N_2' + N_2 \rightarrow 2N_2$ (+ afterglow), N′ being a 2·3-volt metastable atom which is the chemically active species whose energy was measured earlier. No changes are seen in the order of the decay as it proceeds, and the spectral characteristics of the glow between about 5900 and 4000 Å. do not appear to alter. T. H. P.

2835. Axiality of Light Emission and Atomic Structure. Parts IV-VII. J. Stark. *Ann. d. Physik*, 4. 5. *pp.* 607-684, *March* 10; 4. 6. *pp.* 685-724, *March* 26, 1930.

In the previous papers of this series [Parts I–III, *Polytechnische Buchhandlung*, A. Seydel, Berlin, 1927] the spectral and structural analogies, polarisation of light emission and axiality of intensity have been considered. In Parts IV and V the dissymmetry of emission in an electric field and in canal rays is dealt with. The special tubes designed to study the effect are described in detail, including a modification so that light proceeding in opposite directions can be compared in the spectrograph. The latter was a 3-prism instrument of 720-mm. focal length. Studies in hydrogen show that the effect is greater for the $2s - mp^2$ series than for the $2p^2 - mf^3$, d^3 series. Similar results are found in the case of helium. In Part V detailed results are given of observations with canal rays of various velocities. It is found that the mercury line 4359 and the helium lines 5016 and 3965 are displaced towards the violet by an electric field. In Part VI the consequences of the elementary theory of light emission are further discussed [see Abstract 1553 (1929)]. The underlying concepts are

enunciated, and the connection between the change in frequency of a series line in an electric field and the direction of eigen variation is discussed. The connection between this latter and the direction of the emitted light is also considered. The effects of electric field and canal rays are likewise dealt with. Part VII is devoted to a discussion from the point of view of Schrödinger's wave mechanics of Sommerfeld's theorem that atoms such as those of hydrogen, helium, sodium, mercury and carbon are not axial, but spherically symmetrical. F. S.

2836. Zeeman Effect in Band Spectrum of Helium. A. Harvey. *Roy. Soc., Proc.* 126. *pp.* 583–591, *March* 3, 1930.

A continuation of the work by Curtis and Jevons [see Abstract 158 (1929)] on the band spectrum of helium. In the present paper estimates of the magnitudes of the (unresolved) Zeeman patterns of He_2 bands of type $^3D \rightarrow 2P^3\Pi$, and the direction of polarisation in which the lines are widest, are given. The effect differs widely according to the initial term. The conclusion is reached that the Zeeman effect could be used as a measure of the uncoupling between the atoms of the molecule. G. C. McV.

2837. Zeeman Effect of Quadripole Lines. A. Rubinowicz. *Zeits. f. Physik*, 61. 5-6. *pp.* 338–348, 1930.

Spectral lines whose appearance involves a change in the quantum number j of more than 1 must be described in terms of a multipole (*i.e.*, at least a quadripole). For instance, the green auroral line, $^1S_0 - {}^1D_2$ of O I, must be ascribed to a quadripole radiation. In the present paper are given the intensity ratios and polarisation states of the components to be expected in the Zeeman effect of quadripole lines. The positions and polarisations of the components are the same in the longitudinal Zeeman effect as those due to dipole lines. But in the transversal observation of the Zeeman effect the components of the quadripole lines corresponding to $\Delta m = \pm 1$ are π components, and these corresponding to $\Delta m = \pm 2$ are σ components. The $\Delta m = 0$ components are missing in both cases, and can only be seen in an oblique direction, as π — components. The intensities of the various components obey a sum-rule analogous to that for dipole lines. A. C. M.

2838. Positive and Negative Photophoresis of Colloidal Particles in Aqueous Solutions. W. W. Barkas. *Phil. Mag.* 9. *pp.* 505–519, *March*, 1930.

If suspensions of copper, silver, gold or gamboge set up in a rectangular glass cell are allowed to settle in the dark for several hours the falling particles form a horizontal cloud surface some few mm. below the surface of the liquid. If now the cell be illuminated through one of its edges, it is found that the cloud surface is no longer horizontal, the particles appearing to drift toward the source of light and to heap themselves up on the illumined side of the cell. Experiments concerned with this phenomenon of photophoresis, which has already been discussed [see Abstract 979 (1927)] support the view that the observed motions, which may be either positive or negative, are not attributable to convection currents in the liquid as a whole. J. S. G. T.

2839. Scattering Power of Silicon for Molybdenum and Copper Radiation. R. W. G. Wyckoff. *Zeits. f. Krist.* 73. *pp.* 181–186, *Feb.*, 1930.

The intensities of reflection of the Kα doublets of molybdenum and

copper from silicon (finely powdered "amorphous" and "crystalline" material give identical results) have been determined for eight lines by the method previously described [see Abstract 1310 (1930)], and F-values deduced, μ for silicon being calculated as 15·5 for molybdenum and 139·2 for copper Kα radiation, and F(220, NaCl) being taken as 15·62 for both. The difference between the curves for the two radiations, though small, exceeds the apparent limit of error. C. A. S.

2840. X-Ray Scattering Powers of Nickel and Oxygen in Nickel Oxide. R. W. G. Wyckoff. *Phys. Rev.* 35. *pp.* 583-587, *March* 15, 1930.

Atomic F-curves for the nickel and oxygen atoms in NiO have been obtained from measurements of the intensities of the principal powder reflections of molybdenum, copper and nickel Kα radiations. Though the scattering power of oxygen remains nearly constant with respect to NaCl for these wave-lengths, that of nickel shows important variations. [See also Abstracts 1082 and 1310 (1930).] AUTHOR.

2841. X-Ray Spectroscopic Investigations of Certain Solid Double Chlorides. O. Stelling and F. Olsson. *Zeits. f. phys. Chem.* 7. *Abt. B.* 3. *pp.* 210–225, *March*, 1930.

Investigates the K Röntgen absorption spectrum of chlorine in a series of double salts of heavy metals and alkaline chlorides, *chlorosalze*. All the 25 salts investigated, except the zinc compounds, which only give a single absorption head, show two well-separated absorption edges of about the same type as have previously been found where chlorine atoms, bound in such a way that they do not form ions, are present. The wave-lengths of these heads agree well in general with those of the simple chlorides of the heavy metals in question. It is probable that a complex ion ($MeCl_x$) exists, with non-polar union. H. N. A.

2842. Relativistic L-Doublet in the X-Ray Region. J. Zahradníček. *Zeits. f. Physik*, 60. 9–10. *pp.* 712–715, 1930.

Calculates the screening number s, starting from the formula for the wave numbers of the spectra which are similar to that of hydrogen. The resulting values of s point to the fact that the screening number is a function of the atomic number. The author's table agrees with Sommerfeld's values for s from atomic number 41 to 68; with larger atomic numbers there are differences which reach 2 % of the mean value. H. N. A.

2843. L-Series of Element 91—Protoactinium. H. Beuthe and A. v. Grosse. *Zeits. f. Physik*, 61. 3–4. *pp.* 170–173, 1930.

The complete L-series of protoactinium have been photographed and 21 of the lines measured by reference to a standard reference line. F. J. W.

2844. Critical Potentials for the Excitation of Soft X-Rays from Iron. Ann C. Davies, F. Horton, and Edith Blundell. *Roy. Soc., Proc.* 126. *pp.* 661–674, *March* 3, 1930.

Experiments have been carried out to discover how far the proximity of other atoms influences the less firmly bound electrons in the atoms of a metallic surface, by studying the differences in the critical potential curves for the photoelectric effect of soft X-radiation brought about by changes in the temperature of the metallic target. The observations were made upon an iron target over the region 0–220 volts. It is found that heating the target causes a number of new critical points to appear between 112 and

165 volts, which do not disappear when the target is cooled. Only in one case, at 201 volts, does a new critical point develop which demands a hot target for its appearance. It is, therefore, suggested that the new critical points which appear between 112 and 165 volts are associated with changes in the structure of the surface of the iron target brought about by the heat treatment and to some extent possibly by the bombardment itself. Except for the critical point at 201 volts there is nothing to suggest any connection between the critical potentials and the magnetic condition of the iron target or between the critical potentials and the temperature of the target. F. J. W.

2845. Multiple Crystal X-Ray Spectrograph. J. W. M. DuMond and H. A. Kirkpatrick. *Rev. Sci. Instruments*, 1. *pp.* 88–105, *Feb.*, 1930.

The need for improvements in scattered X-ray spectroscopic technique along the lines of increased intensity and contrast is discussed, and a new instrument composed of fifty small units, each a Zeeman spectrograph in itself cooperating to form a single spectrogram, is described in detail. The technique of adjusting the instrument is also described. AUTHORS.

2846. New X-Ray Spectrograph with Absolute Zero-Point Determination Without Divided Circle and Cornu's Zero-Point Method. H. Seemann. *Zeits. f. Physik*, 61. 5-6. *pp.* 416-434, 1930.

The apparatus described embodies a new zero-point method in which the crystal is fixed to a beam which can revolve through 180°. This adjunct can be taken out of the spectrograph and replaced in the opposite direction. The remainder of the paper deals with constructional details and sources of error. F. I. G. R.

2847. Quantitative Analysis by X-Ray Spectroscopy. C. E. Eddy and T. H. Laby. *Roy. Soc., Proc.* 127. *pp.* 20–42. *April* 1, 1930.

The authors' earlier work [see Abstract 3353 (1929)] is applied to the quantitative analysis of alloys of elements of nearly equal atomic numbers with widely varying concentrations, an accuracy of about 0·5 % being obtained. It is assumed that the ratio of the numbers of atoms of two elements in an alloy of metals of nearly equal atomic number is equal to the ratio of the intensities of corresponding lines (say the $K\alpha_1$ lines) in the spectra of the elements, provided that the lines are excited under equivalent conditions. The intensities are determined photographically, this method offering great advantages for line intensity measurements. The effects on the above assumption of the potential applied to the X-ray tube, the variation with wave-length of the absorption and the photographic action of the lines measured, and the non-homogeneity of some of the targets used are discussed and tested experimentally. Contrary to the findings of other investigators, it seems that the presence of a third element does not affect the results of an X-ray analysis of alloys, and that the ratio of the intensities of two lines of a given element is independent of their absolute intensities. The method is applied to alloys obtainable only in small amounts and containing from 0·1 to 0·01 % of the element to be determined. T. H. P.

RADIOACTIVITY.

2848. Distribution of Radioactive Substances between Solid Crystalline and Liquid Phase. V. Chlopin, A. Polessitsky and P. Tolmatscheff. *Zeits. f. phys. Chem.* 145. *Abt. A.* 1. *pp.* 57–78, *Nov.*, 1929.

Deals with the distribution of radium between solid crystalline barium-nitrate and its saturated solution in water at $t = 0°$ and $t = 25°$ C.; also with the distribution of radium between mixed crystals of barium and lead-nitrate in different proportions and their saturated solutions in water at $t = 25°$ C. The original should be consulted for details of experiment and results. A. B. W.

2849. Activity of Lead Taken from the Roof of the Paris Observatory. A. Smits and (Miss) C. H. MacGillavry. *Comptes Rendus*, 190. *pp.* 635–637, *March* 10, 1930.

These papers contain further work on the investigations of S. Maracineanu [see Abstract 669 (1930)], and are now published because of a premature publication by the last-named author. Actually it has not yet been definitely decided whether the radioactivity found upon this lead is really caused by the sun or is a radioactive deposit from the atmosphere or is due to another cause which produces this effect after a long period. The present authors' procedure for detecting traces of mercury by spectrum analysis is described and discussed, since it is incorporated in their sensitive method for the examination of the activity of lead. Maracineanu's results are not verified in general, but only the measurements concerning the radioactivity of the lead from the Paris Observatory. **H. Deslandres** (*ibid.*, pp. 637–639) also contributes to the discussion and opines that solar radiation is the most probable cause of the activity of the lead, basing his viewpoint upon the results of other investigations. H. H. Ho.

2850. Radioactivity Acquired by Materials Exposed to the Action of Atmospheric Agents. A. Lepape and M. Geslin. *Comptes Rendus*, 190. *pp.* 676–678, *March* 17, 1930.

Samples of lead, zinc, slate and dust, removed from an old roof, are found to emit α-rays, but no radiation capable of penetrating 0·05 mm. of aluminium is observed. The activity of the lead is greater than that of the zinc, but practically equal to that of the slate. The radioactivity is, therefore, not peculiar to the lead atoms. In zinc plates the radioactivity is the same on the exposed and protected faces, while in lead the activity of the internal face is one-quarter that of the external surface. The activity does not, therefore, originate from a radiation of solar origin. The radioactivity of the lead appears to be connected with dust adhering to the surface and a radioactive impurity concentrated in a thin superficial layer. A. J. M.

2851. Standardisation of Radium E-Preparations in Radium Equivalents. E. Walling. *Zeits. f. phys. Chem.* 7. *Abt. B.* 1. *pp.* 74–79, *March*, 1930.

This paper contains details of standardisation processes employed for radium E-preparations, and includes a quantitative analysis of pitch-

blende, together with an account of the preparation and purification of lead obtained from it. H. H. Ho.

2852. Mass Defect Curve and Nuclear Constitution. G. Gamow. *Roy. Soc., Proc.* 126. *pp.* 632–644, *March* 3, 1930.

Treats the problem of the constitution of the atomic nucleus more closely than he has previously done, analysing the experimental facts concerning the nuclear energy theoretically by means of wave mechanics. A preliminary equation is obtained for the total nuclear energy, taking into account the Coulomb repulsive forces, which become important for heavy nuclei. The calculations are essentially of a preliminary nature, the accurate wave-mechanical treatment of the model requires Hartree's self-consistent equation. Studies the energy curve, using the experimental data calculated from Aston's mass defects, and finds that if the extra electrons in the nucleus are neglected the theory leads to the conclusion that spontaneous α-disintegration should begin from atomic weight 120 upwards. Considers the manner in which additional pairs of free electrons are added to the nucleus at certain atomic weights, and how each pair temporarily stabilises the nuclei up to a certain atomic weight, where two more free electrons are required. Studies the curve specially for radioactive elements with atomic weight $4n$, thorium and its successive disintegration products. There are three ascending branches of the mass-defect graph, crossing one another near the products of β-ray disintegration. There is an easy possibility of one step transformations from one curve to the other at the junction points. H. N. A.

2853. Expulsion of α-Particles from Atom Nuclei of Radioactive Substances. G. I. Pokrowski. *Zeits. f. Physik*, 60. 11–12. *pp.* 845–849, 1930.

The hypothesis is brought forward that the α-particles of extreme range are accelerated by the γ-radiation. There is thus a close connection between the energies of these α-particles and the distribution of the energy in the γ-spectrum. The results of recent experiments by various observers which tend to support this hypothesis are considered. [See also Abstracts 1491 and 2221 (1930).] Remarks by **H. Herszfinkiel** and **H. Dobrowolska**, *ibid.*, 62. 5–6. *pp.* 432–434, 1930. J. J. S.

2854. Unobservable Electrons and β-Rays. V. Ambarzumian and D. Iwanenko. *Comptes Rendus*, 190. *pp.* 582–584, *March* 3, 1930.

On the analogy of Dirac's theory of light quanta a similar theory regarding β-rays is outlined. As the total number of electrons in an isolated system must be constant the emission of a β-ray must correspond to the transition of an electron from an " unobservable " to an ordinary level. Per contra the transition of an electron to a " reservoir " of such " unobservable " electrons is to be interpreted as a destruction of matter (fusion with a proton). Such transitions correspond to transitions from and to a state of negative energy as suggested by Dirac [see Abstract 2416 (1930)] to explain the solutions of the wave equation corresponding to a negative energy. The expulsion of electrons from different negative levels would explain the diffuse portion of the spectrum of β-rays. C. A. S.

HEAT.

2855. Solution of Certain Cases of the General Equation of Diffusion. R. L. Peek, Jr. *Phys. Rev.* 35. *pp.* 554–561, *March* 1, 1930.

For diffusion in substances for which the conductivity and diffusivity are functions of temperature, the partial differential equation which determines the temperature is non-linear in character. For a certain class of boundary conditions the introduction of an auxiliary function of time and distance reduces this equation to an ordinary differential equation of the second order, in which the temperature and the auxiliary function appear as dependent and independent variables respectively. As this resulting equation can be solved by methods of approximation, the solution to the original equation can be thus obtained. The conditions under which such an auxiliary function exists are examined, and a simple criterion is developed by means of which it may be determined whether such a function exists for any particular case. The method is shown to apply to the case of the semi-infinite solid, and the solution of a particular problem of this type (the cooling of a steel ingot) is given. Another case to which the method applies (diffusion in an axially heated cylinder) is considered, and shown to afford a possible method for determining diffusivity as a function of temperature. It is noted that the method developed is available for the solution of problems in the diffusion of matter as well as of those concerned with the diffusion of heat. AUTHOR.

2856. Thermodynamic Theory of Heat Conductivity. W. Jazyna (Jacyno). *Phys. Zeits.* 31. *pp.* 253–264, *March* 15, 1930.

This is a mathematical paper on the laws of thermodynamics in the light of the recent work of Einstein, de Broglie and E. Schrödinger. The author discusses the form of the laws from the point of view of the connection between matter and energy and connects them with Fourier's theory of heat conduction. Some general problems involving reversible and irreversible processes are then solved by their aid. The discussion of the laws of thermodynamics forms an extension to previous work by the author [see Abstract 1114 (1930)]. T. B.

2857. Point-Source of Heat in a Radiating Plane in Thermal Equilibrium. M. Brelot. *Accad. Lincei, Atti,* 11. *pp.* 268–275, *Feb.* 2, 1930.

The temperature u in a conducting plane of constant conductivity k and variable emissivity E (a function of position in the plane), in a space at zero temperature, satisfies the equation $\nabla^2 u = Eu/k$. When a source is considered, we are concerned with solutions showing a point singularity. Picard has shown that a unique integral exists taking given values on a small Jordan contour surrounding a point O and behaving at points M in its neighbourhood like the function $A.\log OM + V(M)$, where A = constant, and V(M) is such that both OM.V and $OM.dV/d(OM)$ tend to zero with OM. General existence theorems are developed, assuming only that E is positive and has a continuous first derivative in the neighbourhood of O. A point is defined to be a source if $\int (du/dn)ds$ taken around a small Jordan contour has a finite limit as the contour is contracted to the point O. The source is

" simple" if u cannot take positively and negatively infinite values together. It is shown in particular that the above mathematical form is a necessary consequence of the conditions imposed by the physical application, that u is bounded below and is such that $\int(du/dn)ds$ tends to a finite limit as the contour contracts to a point. J. H. A.

2858. Heat Transmission from One Fluid to Another Through a Plate. A. Bernini. *N. Cimento*, 7. *pp.* 81–90, *March*, 1930.

Experiments have been carried out on the heat interchange between fluids flowing in opposite directions on the two sides of a copper plate, chiefly to study the surface resistance at the interfaces. Using water which had been thoroughly boiled to remove dissolved air, and taking precautions to clean the plate (by the use of pumice under boiling water), increased the total transmission some fourfold, as compared with the case where ordinary water was used. When the air-free water and cleaned plate were in use, the coefficient was practically the same whether the fluid on the other side was water or steam. This is in contrast with the case where the colder fluid was ordinary water, with an unprepared plate; in this case the coefficient could be nearly doubled by substituting steam for water on the hotter side. It is concluded that the air layer on the surface is responsible for much of the surface resistance and that when steam is used it sweeps away part of the air layer. The results are stated to be in [qualitative] agreement with Prandtl's hydrodynamic theory.

J. H. A.

2859. Absorption and Emission of Radiant Energy by Carbon Dioxide. W. Gerlach. *Ann. d. Physik*, 4. 5. *pp.* 571–574, *March* 10, 1930.

Radiant energy from a bunsen flame (which contains CO_2) was passed through a vessel filled with CO_2 at different pressures. The beam entered and left the vessel through plates of rock-salt. Two horizontal surface bolometers were placed in the CO_2 vessel, one above and the other below the path of the beam. One of these had a blackened and the other a polished surface, and their positions could be interchanged. After leaving the CO_2 vessel, the beam concentrated on a thermopile so that the absorption in the CO_2 could be measured. If the energy absorbed is emitted again as resonance radiation the effect on the two bolometers will differ independently of their position, being greater for the blackened one than for the polished one. If, on the other hand, the radiation absorbed is converted into heat, which warms the gas, the upper bolometer will always be heated more than the lower one, since heat is conveyed to it by convection currents. The latter effect is the one which was observed to exist.

H. N. A.

2860. Electric Nickel Block Furnace for Metallographic Work. H. v. Steinwehr and A. Schulze. *Zeits. f. Instrumentenk.* 50. *pp.* 194–197, *March*, 1930. *From the Reichsanstalt.*

The furnace is of the type of that of Holborn and Otto [see Abstract 2898, 1926)]. It is a massive vertical cylindrical block of nickel, built up of three superposed cylinders, 10 cm. diameter, 60 cm. high altogether, wound with nickel coils and lagged with asbestos. The whole fits into a cup of fireclay. There are three kinds of vertical perforations in the blocks: three holes, extending to a depth of 40 cm. from the top, take the specimens; three smaller holes for the thermocouples; 20 holes, 5 mm. diameter, near

the circumference, extending right down through the block. Through these small holes air is drawn by a pump when the furnace is quickly to be cooled. The furnace has been used at temperatures up to 800° C., and even 1000° C. [See also following Abstract.] H. B.

2861. Comparator for Determining Expansion of Solids up to 1400° C. W. M. Cohn. *Zeits. f. Instrumentenk.* 50. *pp.* 198–204, *March*, 1930. *Zeits. f. techn., Physik*, 11. 4. *pp* 118–121,1930.

The comparator used for the researches mentioned in the preceding Abstract is a development of that of the Reichsanstalt and consists of a horizontal tubular furnace provided with several jackets and the optical system underneath it. The specimen, a rod 220 mm. long and 8 to 14 mm. diameter, lies on two rings of Marquardt mass in the inner tube of the same unglazed material. The ends of the rod are planed over lengths of 20 mm. and perforated each with twice 6 holes, 0·1 mm. in diameter. These holes replace the usual linear marks; they become invisible when the material begins to glow, unless observed through a blue-glass filter. Through slots in the tube and jackets the rays pass down into vertical tubes and the microscopes and are by prisms reflected into the horizontal micrometer eyepieces. The microscopes are mounted on brackets of indilatan steel which resembles invar. The insertion of wires of platinum or tungsten into the holes did not give satisfaction. The inner tube is 680 mm. long and has diameters of 18 and 24 mm, and is wound with platinum coils in several circuits; the second tube, also of Marquardt porcelain, has diameters of 46 and 52 mm. and is wound with nichrome. There is a third tube and finally a shell of aluminium, and on the lower half a water jacket, to protect the optical system. The specimen is longitudinally perforated to take the thermocouple. H. B.

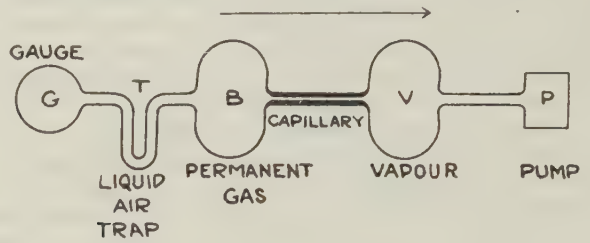
2862. Automatic Recording of the Infra-Red at High Resolution. F. S. Brackett and E. D. McAlister. *Rev. Sci. Instruments*, 1. *pp.* 181–193, *March*, 1930.

The authors describe how they have utilised a spectrometer of the Littrow type for automatic registration of the direct intensity measurements in the near infra-red spectrum. Special attention has been given to the thermocouple and housing to attain stability of record. The radiant energy input tubes pass through a small aperture placed in front of the thermocouple, the hot junction of which was placed in a *Hohlraum* whose temperature is that of the cold junction. The authors make an analysis of the optimum conditions for the construction of single junction thermocouples and have developed thermocouples with receivers of only 0·1 mm. width. This has permitted narrower slit widths and greater resolving power. High sensitivity of the receiver requires a high value of $\epsilon/k\sigma$ for a receiver of given area, where ϵ = thermoelectric power, and k and σ refer respectively to the coefficient of heat conduction and the specific resistance of the wires. The couples chosen were, therefore, of Bi and an alloy of Bi and Sn. One of these thermocouples, having a time of response of 2·5 sec., had a sensitivity ten times as great as a Moll " linear " thermocouple having the same width of receiver. W. C. S. P.

2863. Low-Pressure Tensimeter. K. C. D. Hickman. *J. Phys. Chem.* 34. *pp.* 627–636, *March*, 1930.

Description of a convenient apparatus for measuring vapour pressure between the atmosphere and 0·05 mm. of mercury; it is especially recom-

mended for gasolines and for heavy lubricating oils. The apparatus has been developed from the principle shown in the diagram. The substance providing the vapour is placed in the bulb V, and its surface is large compared with the capacity of the pump, so that a saturated vapour is always maintained during the operation of the pump. At the commencement of evacuation the pressure in the system is much higher than the vapour pressure of the substance, and the pressure will fall uniformly throughout.



When the pressure of the substance is nearly reached, the pump will be concerned almost entirely with the removal of vapour. No more of the permanent gas will stream from B into V, although a little will diffuse through the vapour column. The gauge will then indicate the pressure of the vapour. Dry nitrogen is used as the permanent gas, and a McLeod gauge is utilised to measure the pressure. W. C. S. P.

2864. Automatic Mercury Still. A. Krethlow. *Zeits. f. techn. Physik*, 11. 5. *pp.* 159–160, 1930.

The still of "double barometer tube" pattern is made of Pyrex glass and is heated from a.c. mains. Electrodes are placed in the distillation vessel and in the supply reservoir, the heating current being broken by means of a relay when the mercury supply runs low; the primary relay current is obtained from the secondary of a small mains transformer. The still handles 700 gm. of mercury per hour, with an expenditure of 150 watts. The mercury should previously be freed from grease and from base metals. L. V. C.

2865. Molecular Weights and Melting Points of Organic Compounds. J. B. Austin. *Am. Chem. Soc., J.* 52. *pp.* 1049–1053, *March*, 1930.

The formulæ of Longinescu and Lindemann, as well as the "Crompton-Walden Rule," are referred to. A simple relationship between the melting points and molecular weights of organic homologues is derived. The equations deduced apply only to true homologues. The normal paraffin series has one curve, and the secondary paraffins another. Failure also results if an attempt is made to include ortho-, meta-, and para-isomers in one curve. J. K.

2866. Redetermination of the Limiting Value of the Expansion and Tension Coefficients of Gases. Part II. Neon. W. Heuse and J. Otto. *Ann. d. Physik*, 4.6. *pp.* 778–780, *March* 26, 1930.

A new determination has been made by the method described in Part I [see Abstract 713 (1930)], in the pressure region 994 to 1363 mm. Hg, using the same gas with which the inclination of the isothermals had previously been determined. The value obtained for $\gamma \cdot 10^7$ from α and β was $36{,}610_4$; the mean between this value and those for He, H_2 and N_2 taken from Part I is $36{,}608_6$; the mean for the four gases according to previous

Reichsanstalt measurements is $36{,}607_{,0}$ and the mean of these two values is $36{,}607_{,7}$. This gives the absolute temperature of the freezing point $T_0 = 1/\gamma_m = 273{\cdot}16°$ Abs. The inclination of the isothermals found by measurements at small pressures and the values extrapolated to $p = 0$ from measurements at high pressures agree well with one another.

H. N. A.

2867. Measurement of Specific Heats. S. Chapman. *Roy. Soc., Proc.* 126. *pp.* 675–682. *March* 3, 1930.

A note on the papers by Blackett, Henry and Rideal [see Abstract 2234 (1930)] on the same subject, suggesting a different application of the principle used and discussed by them. The theory of the suggested application is first elucidated and then detailed corrections are appended. The method here proposed is a null or balance method, in which temperature differences are annulled and not measured. The only measurement is that of the flow ratio, which for most pairs of gases will be neither large nor small. The details involved are discussed and the differences from the method of Blackett, Henry and Rideal carefully set out and compared.

S. G. B.

2868. Specific Heats of Solid Substances at the Temperatures Obtainable with the Aid of Liquid Helium. Part II. Atomic Heats of Lead and of Bismuth. W. H. Keesom and J. N. van den Ende. *K. Akad. Amsterdam, Proc.* 33. 3. *pp.* 243–254, 1930. *Comm. No.* 203*d from the Phys. Lab., Leiden.*

This is a repetition and continuation of measurements made by W. H. Keesom and D. H. Andrews [see Abstract 391 (1928)], which were not as accurate as desired; and, in addition, measurements are also recorded on bismuth as having a heat capacity per $cm.^3$ of the same order of magnitude as that of lead at the temperatures chosen for experiment. Improvements in the methods employed are specified, and the results are now very regular, agreeing well with a Debye-curve over the whole range investigated. Tables and curves accompany the paper.

T. B.

2869. Heat Capacities of Organic Compounds at Low Temperatures. Part III. Adiabatic Calorimeter. J. C. Southard and D. H. Andrews. *Frank. Inst. J.* 209. *pp.* 349–360, *March*, 1930.

An adiabatic calorimeter for heat capacities at low temperatures has been devised which gives results consistent to about 0·5 %. It is faster and simpler in operation, more economical than the present most used type and applicable to a wider range of organic compounds because of its small size (8 cc.). The heat of fusion of toluene was found to be 1584 cal./mol. at 177·94° K. The heat capacity of toluene was found from 100° K. to 250° K. by comparison with benzene. [See also Abstract 2231 (1929).]

AUTHORS.

2870. Calorific Value of a Small Quantity of Gas by the Union Calorimeter. A. Blackie. *Journ. Sci. Instruments*, 7. *pp.* 84–89, *March*, 1930.

The chief source of error was found to arise from the fact that the electrolytic gas generated as a standard of comparison had not the theoretical composition. Appreciable quantities of ozone were found in the gas, and both ozone and persulphuric acid in the electrolyte. The quantities of these substances formed were determined by analysis, and it was found that when the appropriate corrections were applied the major part

of the errors was accounted for. By taking a corrected figure for the calorific value of the electrolytic gas formed in the apparatus, the residual errors can be reduced to about 0·5 % for gases of 500 B.Th.U. per cubic foot and to about 2 % for gases of about 900 B.Th.U. per cubic foot. In other respects the instrument proved itself to be convenient and rapid in use. AUTHOR.

2871. Isothermal Determination of Small Positive Heat Tones. A. Wassermann. *Zeits. f. phys. Chem.* 146. *Abt. A.* 6. *pp.* 409–417, *March*, 1930.

In this paper a detailed description of a new calorimeter is given, with methods of calibration, designed for the purpose of making measurements according to v. Wartenberg's method [see Abstract 2899 (1926)]. Data for the apparent heat of dilution of ammonium nitrate are included.

H. H. Ho.

2872. Effect of a Permanent Electrical Dipole on the Internal Latent Heat of Vaporisation of a Liquid. A. R. Martin. *Phil. Mag.* 9. *pp.* 422–425, *March*, 1930.

According to modern ideas of the electrical structure of matter, the internal latent heat of vaporisation of a liquid may be regarded as the work required to separate the molecules of the liquid to an infinite distance from each other against the attractive forces due to the electric field around each molecule. The work of vaporising a single molecule is, therefore, neglecting electrical saturation effects, the change in energy in the medium resulting from the transfer of the molecule to a vacuum from a medium of dielectric constant equal to that of the liquid. The author has previously shown that in so far as the molecule may be regarded entirely as a permanent electrical dipole this energy change is given by the expression $\frac{\mu^2}{3a^3}\left(1 - \frac{1}{D}\right)$, where μ = the moment of the dipole, a = the radius of the molecule, D = the dielectric constant of the liquid. This expression should, therefore, give the effect of a permanent electrical dipole on the latent heat of vaporisation of a liquid. In applying this idea, that part of the latent heat which is not due to the dipole is allowed for in organic compounds by subtracting from the total latent heat the values for the alkyl and phenyl groups derived from the latent heats of the parent hydrocarbons. The values of " a " required to give the observed effect of a dipole on the internal latent heats of vaporisation of 21 liquids are tabulated. The internal latent heats are given in joules per mol. and are denoted by $\Delta\lambda_i$ and that portion of them due to the dipole is signified by λ_i. The table is comprehensive and its results are briefly discussed. S. G. B.

2873. Thermodynamics of Caoutchouc. L. S. Ornstein, J. Wouda and (Miss) J. G. Eymers. *K. Akad. Amsterdam, Proc.* 33. 3. *pp.* 273–279, 1930.

The piece of rubber studied was believed to be without hysteresis, although at elongations of the order 250 % it gave greater elongations as the stretching force was diminished than during the increase of force. This effect is attributed to phase-changes which have a considerable lag, and not to true hysteresis. If this is so, the specimen, unlike those dealt with previously by the same authors [see Abstract 1529 (1930)], should obey the laws of thermodynamics. By measuring the elongation at different forces for a series of temperatures, and also the specific heat, the temperature

change during an adiabatic stretching may be calculated. This was found to agree with direct measurements of the same quantity, up to elongations of 150 %, thus verifying the application of thermodynamics to the substance. J. H. A.

2874. Temporal Course of Thermodynamic Processes and Dependent Hysteresis Phenomena. N. v. Raschevsky. *Zeits. f. Physik*, 60. 3–4. *pp.* 237–242, 1930.

The differential equation relating to an unstable thermodynamic system, deduced in a previous paper [see Abstract 2789 (1929)], is further discussed and illustrated by numerical examples. The following conclusion is derived. In order that a system may pass from one state of equilibrium to a neighbouring stable state, external forces must exceed a definite minimum value. If this minimum value is not reached the forces remain ineffective over any period of time whatsoever. In the event of the limiting value being attained, the external forces must be operative for a definite interval of time in order to produce a desired irreversible effect. This interval is shorter in proportion as the forces are greater. In the case of impulsive external forces, their limiting effect must be produced a number of times in order that the system may pass to its new state of equilibrium. J. S. G. T.

2875. Cosine Law as a Consequence of the Two Main Laws of Thermodynamics. P. Clausing. *Ann. d. Physik*, 4. 5. *pp.* 533–570, *March* 10, 1930.

A mathematical discussion which develops expressions to show that the cosine law of the molecule is a consequence of the two main laws of thermodynamics. The principle of detailed equilibrium necessitates the equality of adsorption and emission from the molecule in each direction. It is easily understood that the cosine law is closely connected with thermodynamical conditions, but it is more difficult to show that kinetically the reflection and emission together make up perfectly the cosine law so that if there is no reflection at all the emission alone follows the cosine law. The above statements are developed and explained in the paper. Several numerical examples are given, and the variation from the second law, particularly the case of the form $P \cdot \cos^k \vartheta d\Omega \cdot dS$, for the expression involved, is dealt with in detail. Other parts of the paper are devoted to the amplification of a special case and to a survey of the literature, and an addendum deals with the special example of two large cylindrical containers connected by a narrow tube. S. G. B.

2876. Simple Equation for Joule-Thomson Effect in Real Gases. J. A. Beattie. *Phys. Rev.* 35. *pp.* 643–648, *March* 15, 1930.

Simple approximate relations are given for μC_p and the pressure variation of C_p expressing these quantities as functions of the independent variables p and T. They are derived from the usual thermodynamic relations by use of one form of the Beattie-Bridgeman equation of state, which expresses V as an explicit function of p and T. The values of the Joule-Thomson coefficient μ for air and for ammonia calculated from the relations for μC_p and C_p, equations (10) and (4) respectively, agree well with the observed values in the case of air, and fairly well for ammonia. The approximate equation for μC_p calculates values of the inversion temperatures of the Joule-Thomson effect in air which are in good agreement with the experimental results. [See also Abstract 712 (1930).] Author.

SOUND.

2877. Absorption of Sound at Oblique Angles of Incidence. P. R. Heyl, V. L. Chrisler and W. F. Snyder. *Bureau of Standards, J. of Research*, 4. *pp.* 289–296, *Feb.*, 1930.

The absorption of sound at oblique angles of incidence has up to the present been purely a matter of theory, no experimental work having been published on the subject. Theoretical discussions have been given, which appear to be in error in an essential point, namely, the overlooking of the probable existence of rotational motion in the region of absorption. This paper describes experiments made to investigate this question. It is found that the absorption varies with the angle of incidence, but not according to the law which has been deduced from purely theoretical considerations. As a consequence of the experiments the conclusion is reached that the tube method of measuring absorption is limited in its application to the relative comparison of samples of a similar nature, and that for absolute values of absorption the reverberation method is the only trustworthy one. AUTHORS.

2878. Sounds Emitted by Aircraft. J. Obata and Y. Yosida. *Tokyo Univ. Aeronaut. Research Inst., Report, No.* 59 [185 *pp.*], *March*, 1930. *Phys. Math. Soc., Japan, Proc.* 12. *pp.* 80–92, *April*, 1930. *In English.*

Describes the electrical method used for recording the sounds emitted by various types of aircraft. These included a bomber, a chaser, a reconnaissance machine and a small dirigible. Straight-line flights and vertical turns were made. The sounds are generally very complex in nature, overtones being predominant in most cases. At short distances the exhaust sound predominates, while at longer distances the propeller provides the greater part of the sound, the fundamental and second harmonic being predominant. Different aeroplanes equipped with the same kind of engine gave different records. The pitch of the fundamental depends far more on the number of cylinders per bank than on the total number of cylinders in the engine. A large number of the records obtained are reproduced in the paper. J. W. T. W.

2879. Vibrations of Membranes in a Pulsating Fluid. W. Kucharski. *Phys. Zeits.* 31. *pp.* 264–280, *March* 15, 1930.

A contribution to the resonance theory of hearing. A theory is developed for the vibrations of a membrane stretched in a fluid and forming a simplified model of the human cochlea. The membrane is set in vibration by pressure due to mass and to friction, and equalisation of pressure takes place chiefly through the helicotrema or aperture at the apex of the cochlea. The form of the membrane is determined and discussed. G. E. A.

2880. Resonator Periods by Acoustic Impedance Method. E. J. Irons. *Phil. Mag.* 9. *pp.* 346–360, *March*, 1930.

The principles of acoustic impedance are used to calculate the natural periods of a number of different forms of resonator, some of which include a conical horn. It is shown that if spherical waves are postulated,

Webster's differential equation is still obtained for conical horns without restriction as to cross-section. W. H. Ge.

2881. Velocity of Sound at Ultrasonic Frequencies using Quartz Oscillators. C. D. Reid. *Phys. Rev.* 35. *pp.* 814–831, *April* 1, 1930.

The velocity of sound was measured at frequencies 40 to 216 kc. per sec. using quartz crystals as sound oscillators. The sound emitted is reflected back upon the source and as its phase changes the plate current of the quartz oscillator passes through a series of maximum values (Pierce's method). The distance moved by the sound reflectors between these maxima is a half wave-length of the emitted sound. The velocity was determined in air, free from CO_2, at three values of humidity, *viz.*, dry, 45 % humidity at 20° C., and in air saturated with water vapour at 20° C. The velocity was found to decrease with increasing distance from the source, approaching asymptotically to a value 331·60 m./sec. at a distance of 45 cm. from the source. The effect of humidity was found to be expressed by $V_H = V_0 + 0{\cdot}14H$, where V_0 is the velocity in dry air at 20° C. and V_H is the velocity at any relative humidity H at 20° C. A. B. W.

2882. Velocity of Longitudinal Waves in Liquids at Audio-Frequencies. L. G. Pooler. *Phys. Rev.* 35. *pp.* 832–847, *April* 1, 1930.

This paper deals with a series of measurements of the velocity of sound in water and in solutions of NaCl and KCl. The method employed is the resonant-tube—a steel tube filled with liquid is resonated by means of a diaphragm at the bottom excited electromagnetically. A correction is applied for the yielding of the walls of the tube—tubes of different dimensions being used to test various theoretical correction formulæ (*viz.*, those of Korteweg, Lamb and Gronwall). The velocity of sound in air-free distilled water at 25° C. was found to be $1485{\cdot}4 \pm 2{\cdot}3$ m./sec. (an average of 52 observations). A. B. W.

2883. Approximate Networks of Acoustic Filters. W. P. Mason. *Bell System Techn. J.* 9. *pp.* 332–340, *April*, 1930.

The theory of acoustic filters given by Stewart is based upon the representation of such filters by means of lumped constants in the form of a T network. The author has since presented a theory showing that acoustic filters are equivalent to a combination of electric lines. Lines as an approximation can be represented by networks with lumped constants, and hence an acoustic filter has a lumped-constant approximation network which should represent the filter well at low frequencies. Stewart's network is a first approximation to the network of electric lines. This first approximation does not very adequately represent the band-pass filters and, therefore, a second approximation is developed. All single band-pass filters have been analysed and design formulæ are given for them in terms of the second approximation network. From these formulæ it is possible to determine the physical dimensions necessary for an acoustic filter so that it may have a given attenuation and impedance characteristic. J. J. S.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

2884. Electrostatic Problems. U. Cisotti. *Accad. Lincei, Atti*, 11. *pp.* 243–246, *Feb.* 2, 1930.

Consider a cylindrical insulated conductor electrified in such a way that the electrical field maintained by it is identical in every plane section normal to the generatrix, the elements characteristic of the field being the same in the same straight line parallel to the generatrix. The field is then completely characterised when its behaviour is known in a generic plane section normal to the generatrix. Another form of the formula of Coulomb is considered, and the determination of the distribution of electricity on a rectilinear conductor, the quantity of electricity and the form of the conductor being known. The inverse problem is also dealt with: what must be the form of such a conductor so that the electrical density upon it may be assigned *a priori*? J. J. S.

2885. New Piezo Oscillations with Quartz Cylinders Cut Along the Optical Axis. A. Hund and R. B. Wright. *Bureau of Standards J. of Research*, 4. *pp.* 383–394, *March*, 1930. *I.R.E., Proc.* 18. *pp.* 741–761, *May*, 1930.

It is shown that oscillations of a new type can be produced, using a quartz cylinder cut along the optical axis. Some of the electrode mountings used were suggested by Röntgen's experimental work and the more recent work of Tawil [see Abstract 1615 (1929)]. In order to produce these oscillations it was necessary to use new adaptations of regenerative circuits as the driving circuit. These oscillations were studied experimentally through the medium of glow discharge patterns, a phenomenon of ionisation produced by the quartz cylinder oscillating in a few mm. of helium, and theoretically by comparing the observed frequencies of oscillation with the computed values for the three different types or modes of vibration. Both studies indicate that these oscillations are of a true piezoelectric character. AUTHOR.

2886. Effect of Occluded Gas on Air Condensers at Radio Frequencies. Hazel M. Fletcher. *Phil. Mag.* 9. *pp.* 464–473, *March*, 1930.

Experiments show that radio-frequency currents do not pull out an appreciable amount of adsorbed gas from the metal plates of condensers as assumed by Morris. The resistance of condensers varies considerably with the amount of moisture present. Also, the dielectric losses and the metallic resistance vary with the wave-length. E. E. F. d'A.

2887. Investigation of a Dielectric Field by means of the Kerr Effect. G. J. Dillon. *Zeits. f. Physik*, 61. 5–6. *pp.* 386–394, 1930.

A tube filled with nitrobenzol was introduced between the first Nicol and a Babinet compensator. The vertical fringes due to the latter were distorted owing to changes of conductivity in the dielectric. E. E. F. d'A.

2888. Complex Nature of Dielectric Absorption and Dielectric Loss. E. J. Murphy and H. H. Lowry. *J. Phys. Chem.* 34. *pp.* 398–520, *March*, 1930.

This investigation has been made with particular reference to the influence of ions adsorbed on inner surfaces. In most solid dielectrics direct-current conduction appears to take place not uniformly through the material, but through a system of conduction paths of sub-microscopic dimensions dispersed in the insulating medium in a manner related fundamentally to the structure of the material. This conclusion is based chiefly upon Smekal's investigations of crystalline dielectrics and the authors' results for textiles. A picture of the structure of a dielectric is discussed in which free ions, adsorbed ions and neutral molecules may each contribute to the total dielectric absorption (residual charge) and dielectric loss, whilst the relative prominence of each of these components will depend on the type of dielectric, the temperature, and other factors. The existence of layers of adsorbed ions with different relaxation times is found to provide a new physical interpretation of von Schweidler's theory of dielectric absorption and loss. An attempt is made to explain variations in power factor and dielectric constant in rubber with changes in sulphur content on the adsorbed ion hypothesis. An important property of adsorbed ions in solids or ionic dipoles in liquids is that as the strength of the applied field is increased adsorbed ions should become " desorbed " and ionic dipoles separated into their constituent ions. This affords the possibility of relating the changes in the conductivity of dielectrics with voltage to other electrical properties such as absorption. H. H. Ho.

2889. Measurement of the Dielectric Constant and Index of Refraction of Water and Aqueous Solutions of Potassium Chloride at High Frequencies. F. H. Drake, G. W. Pierce and M. T. Dow. *Phys. Rev.* 35. *pp.* 613–622, *March* 15, 1930.

The dielectric constant of distilled water measured with a vacuum source of voltage was $\epsilon = 78{\cdot}57$ at 25° C. and independent of the period within the range employed, and the temperature coefficient between 10° and 60° C. satisfied the empirical equation:

$$\epsilon_t = 78{\cdot}57\ [1 - 0{\cdot}00461(t - 25) + 0{\cdot}0000155(t - 25)^2 \ . \ . \ .],$$

but this equation was uncertain between 4° and 10°. With distilled water, tap water and aqueous solutions of KCl of conductivity ranging from $(0{\cdot}97 - 178) \times 10^7$ e.s.u., the dielectric constant was found to be only slightly dependent on the ionic concentration of the solution and nearly the same as that of pure water. The method employed consisted in the measurement of standing electric waves between a pipe and a wire concentrically located within the pipe. The liquid is the dielectric between the wire and the pipe. The frequencies employed were accurately measured by a piezo crystal standardising a zero beat method, and the half wavelength within the dielectric was obtained by moving a piston in the liquid and observing reactions on the source. A theoretical discussion of the method is given. H. H. Ho.

2890. Measurements of Dielectric Constants of Conducting Media. J. Wyman, Jr. *Phys. Rev.* 35. *pp.* 623–634, *March* 15, 1930.

It is possible to build small, rigid circuits which have natural periods determined by the medium in which they are immersed. If $T\gamma$, the

product of the natural period of the circuit and the conductivity of the medium, is sufficiently small, this period is proportional to the square root of the dielectric constant of the latter. On the basis of this fact measurements have been made of the dielectric constant of water from 0° to 100° C. to an accuracy of 0·2 % or better and covering a range of frequency from $T = 1{\cdot}4 \cdot 10^{-8}$ to $81 \cdot 10^{-8}$. If $T\gamma$ is not sufficiently small, the period is affected by the conductivity of the medium in a complicated way and cannot be used to obtain the dielectric constant. With the smallest circuits used measurements of the dielectric constants of liquids having conductivities as high as 100 times that of water can be made.

AUTHOR.

2891. Temperature Dependence of Molecular Polarisation, Particularly of Substances with Freely Rotatable Groups. L. Meyer. *Zeits. f. phys. Chem.* 8. *Abt. B.* 1–2. *pp.* 27–54, 1930.

Euchen and Meyer's qualitative work [see Abstract 273 (1930)] is now investigated quantitatively. When the inner molecular potential which hinders rotation does not exceed $1/10kT$, then rotation may be produced for the molecular polarisation, this upper limit holding good for ethylene chloride and the COOH-group. Above $1/10kT$, rotation is hindered, and there results a temperature dependence of the total moment in the sense that it decreases with falling temperature, and the molecular polarisation is no longer a linear function of $1/T$. From experiments in dilute dipole free solution, it is shown that where $1/10kT$ is not exceeded (*e.g.*, in hydroquinone diethers) the above linear relationship exists. Dipole free substances exhibit a feeble rise of molecular polarisation with temperature, which is explained by a thermal relaxation of the molecule with increased mobility of the electrons, since the molecular refraction exhibits a parallel phenomenon. The correctness of the factor $4\pi/3$ for the inner field in dilute solutions is established beyond doubt, since the temperature dependence of the molecular polarisation for ethyl ether in benzene solution affords the same value for the dipole moment as evaluated in the gaseous state.

H. H. Ho.

2892. Dipole Moments of Some Alcohols and Esters. H. L. Donle and K. L. Wolf. *Zeits. f. phys. Chem.* 8. *Abt. B.* 1–2. *pp.* 55–59, 1930.

The moments of menthol ($1{\cdot}54 \times 10^{-18}$) and borneol (1·56), of the menthyl esters of formic (2·06) and acetic acids (1·83), and of the bornyl esters of formic (2·04), acetic (1·87) and propionic (1·84) acids, are communicated. The moments of both alcohols are of the same magnitude as those of the aliphatic alcohols, so that the structure of the ring system is without measurable influence on the moments; the moments of the esters exhibit the same course with the chain of the acid residue as the moments of the acids themselves.

H. H. Ho.

2893. Dipole Moments and Ultra-Violet Absorption of Organic Molecules. H. L. Donle and G. Volkert. *Zeits. f. phys. Chem,* 8. *Abt. B.* 1–2. *pp.* 60–71, 1930.

The dipole moments are recorded of menthone (2·8), cyclopentanone (3·0), camphor (2·95), fenchone (2·92), anisole (1·23), dianisylmethane (1·61), benzophenone (2·95), dianisylketone and dianisylthioketone (4·44). It follows that the dipole moment of the alicylic ketone with a five-membered ring somewhat deviates from that of the other ketones (positive

ring tension) and that the CS-group adds a somewhat greater moment than the CO-group. The measurement of the ultra-violet absorption bands confirms the regularities found for the aliphatic ketones. Comparison of the curves for the dianisylthioketones and ketones also shows the greater contribution of the CS-group than the CO-group. H. H. Ho.

2894. Dipole Moments of Some Organic Molecules. K. L. Wolf. *Phys. Zeits.* 31. *pp.* 227–229, *March* 1, 1930.

This work continues a previous series of investigations [see Abstract 2945 (1929)] and is carried out by the methods and apparatus already described (*loc. cit.*). Since many of the substances examined were only sparingly soluble in benzene, the measurements have been made to an extraordinary degree of accuracy by an increase of capacity of the liquid condenser, and have been carried out at a wave-length of about 800 m. and at 22°. A short discussion is included concerning the emission of the infra-red term of the molecular polarisation, which, being usually neglected, causes the moment to be too great. Data are given for the following substances: menthone, camphor, fenchone, acetylacetone, formic, acetic, propinic, butyric and isovaleric acids, diazoacetic ester, benzophenone, dianisylmethane, dianisylketone and dianisylthioketone. The latter have somewhat greater moments than the aliphatic ketones.

H. H. Ho.

2895. Observations on Atmospheric Electricity in Country Air. J. J. Nolan and P. J. Nolan. *Gerlands Beitr. z. Geophys.* 25. 3–4. *pp.* 414–428, 1930.

Observations for 12 months of atmospheric ionisation and nucleation made at Glencree, 18 km. S. of Dublin, are tabulated to find how the concentration of small ions is affected by the number of condensation nuclei in the atmosphere. The concentration of ions was obtained by an Aitken pocket dust counter and varied from 10,700 for N. winds to 540 with W. winds. The average value of the ratio of total nuclei to uncharged nuclei was 1·90. The average concentrations of small ions were $n_+ = 388$ and $n_- = 283$. The average value of the ratio n_+/n was 1·45, small compared with those of other observers, but was less during rain. With heavy rain there was production of ions and nuclei by splashing of raindrops. With some exceptions the relations between ions and nuclei fitted the equation $q = \alpha n^2 + \zeta n\sqrt{Z}$, where q is the number of pairs of small ions produced per c.c. per sec. and has an average value of 5, n is the concentration of small ions, α the recombination coefficient of + and − ions, Z the total number of condensation nuclei and $\zeta = 55 \times 10^{-5}$. [See Abstract 2265 (1929).] R. S. R.

2896. Relation of Space Charge and Potential Gradient to the Diurnal System of Convection in Lower Atmosphere. J. G. Brown. *Terr. Mag.* 35. *pp.* 1–16, *March*, 1930.

The mean electric field of the earth is characterised by a negative surface charge and a positive space charge in the atmosphere. The mean distribution of the positive space charge can be inferred from the values of the potential gradient at different elevations, since $d^2V/dh^2 = 4\pi\rho$. Approximate computation shows that 50 % of the charge is in the first km. Variations in distribution will cause variations in potential gradient at any point by changing the relative magnitude of the space charge (*a*) in horizontal layers and (*b*) in vertical columns. Expansions or contrac-

tions and convection currents will produce such changes in distribution and hence determine the character of the changes in potential gradient. Continuous records of space charge and potential gradient have been obtained for a year 7·5 m. above the ground, and their diurnal variations have been compared with the diurnal system of convection as inferred from the variation in the meteorological elements. It is concluded that for this set of records the diurnal variation of the potential gradient is satisfactorily accounted for on this theory. AUTHOR.

2897. Preliminary Results of Ocean Magnetic Observations on the "Carnegie" from Hawaii to Samoa, October to November, 1929. J. P. Ault. *Terr. Mag.* 35. *pp.* 17–21, *March*, 1930.

2898. Summary of Year's Work, Department of Terrestrial Magnetism, Carnegie Institution of Washington. J. A. Fleming. *Terr. Mag.* 35. *pp.* 43–46, *March*, 1930.

An extract from the annual report for the year ending June, 1929. Automatic registration of the electric state of the atmosphere has speeded up the observation-rate tenfold, and records for 110 complete days free from negative potentials have been obtained. The diurnal variation in the effective height of the Kennelly-Heaviside layer has been measured, and the simultaneous presence of about thirty separate paths for 70-metre radio waves at night between stations 7 miles apart has been discovered. Oil-immersed X-ray tubes have been developed which work at 1,400,000 volts. The lag between solar activity and magnetic activity is found to be from six to nine months. Problems relating to the earth's crust, to the magnetic elements, and many other lines of investigation are indicated as occupying the attention of the Department. G. E. A.

2899. Magnetic Properties of Rocks. G. Grenet. *Ann. de Physique*, 13. *pp.* 263–348, *March*, 1930.

The paper opens with an historical introduction. The apparatus employed in the measurements consisted of a magnetic balance of the Curie-Cheneveau type as modified by the author, and a Hughes induction balance adapted to obtain the susceptibilities of rock specimens rapidly. The conclusions of the author are: Although the petrographic classification of rocks does not correspond with that of their magnetic properties, those rocks which are rich in ferromagnetic constituents are, on the whole, more magnetic than those in which the ferromagnetic content is small. The values of susceptibility found may be explained by the magnetite content in the specimens. Magnetite is the principal but not the only magnetic constituent in rocks. The increase of susceptibility of certain rocks as the result of heating has been related to the changes which have taken place in their mineral constituents. A slight degree of magnetic anisotropy is found in rocks formed from the fluid state. The paper contains tables of the susceptibilities of nearly 300 rocks and minerals, illustrations of rock sections, and a full Bibliography. G. E. A.

CURRENT ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM.

2900. Conduction of Electricity in Metals and Allied Phenomena. T. E. Stern. *Roy. Soc., Proc.* 126. *pp.* 570–582, *March* 3, 1930.

The classical theory of conduction in metals, as worked out by Lorentz

and others, is briefly contrasted with Sommerfeld's modification, in which the supposition is made that the distribution of electrons within the metal obeyed not the classical but the Fermi-Dirac statistics. With the classical theory one could investigate many of the properties of electrical circuits either by special transport theories or, equally well, by the more general theories about matter in equilibrium, and often obtain identical results by the two different methods of procedure. On the new statistics this is no longer the case. It is here shown that the discrepancies are due to the illegitimate application of equilibrium theories to essentially transport problems. There exist, in general, two classes of phenomena associated with electricity in metals: (1) phenomena associated with the flow of electricity in closed circuits, which may be investigated only by making use of transport theories; (2) phenomena associated with insulated conductors, which may be investigated by general theories of equilibrium. The various consequences of this difference, such as the difference between the cooling effects of the evaporation of electrons from insulated and from uninsulated conductors, are investigated and the phenomena arising in the case of non-isotropic conductors are specially considered. A. W.

2901. Mechanism of Ionic Conduction in Good-Conducting Solid Compounds. W. Jost. *Zeits. f. phys. Chem.* 7. *Abt. B.* 3. *pp.* 234–243, *March*, 1930.

Continues the controversy with A. Smekal [see Abstract 1558 (1930)], and answers a number of points raised by him in a recent paper [see Abstract 2933 (1929)]. H. N. A.

2902. Electrical Properties and Structure of Metallic Films prepared by Thermal and Kathodic Projection. F. Joliot. *Comptes Rendus*, 190. *pp.* 627–630, *March* 10, 1930.

It has been maintained that metallic films prepared by kathodic sputtering are crystalline in structure, while those prepared by the thermal process are amorphous. The author's investigation of the thermal behaviour of the resistance of both kinds of film leads him to the conclusion that both possess the same type of crystalline structure, whilst such differences as may be observed are attributable to occluded gas. J. S. G. T

2903. Carbon Line Resistances. J. B. Seth, C. Anand and G. L. Puri. *Phil. Mag.* 9. *pp.* 415–422, *March*, 1930.

A continuation of previous work [see Abstract 1310 (1929)] on the change in electrical resistance with humidity of pencil or carbon lines drawn on non-conducting surfaces, *e.g.*, ebonite. Two methods of observation were carried out (1) in stationary air, (2) in an air current. Further observation was made of the behaviour in air at low pressures and in nitrogen. The object was to discover a means of utilising the phenomenon for humidity measurements, and from the results it would appear that if a pencil line was to be so used, then it is more profitable to study the drying curves for the line owing to their greater regularity than the wetting curves. The paper consists of a description of experiment and observation in treatment of the various conditions in a number of ways. S. G. B.

2904. Resistance Measurements with Variable Currents. E. Wiegand. *Ann. d. Physik*, 4. 6. *pp.* 781–822, *March* 26, 1930.

A detailed description of a method of comparing resistances with variable currents using a Bellati dynamometer and wireless valves with

various types of Wheatstone bridges. The measurement of resistance in this way has an accuracy of 0·00001 % and of capacity, 0·001 %.

G. C. McV.

2905. Increase of Electrical Resistance of Bismuth Monocrystals due to Magnetic Fields at Low Temperatures. L. Schubnikow and W. J. de Haas. *K. Akad. Amsterdam, Proc.* 33. 2. *pp.* 130–133, 1930. *Comm. No.* 207*a from the Phys. Inst., Leiden.*

Two wires formed of monocrystals of bismuth, with the principal axis parallel to the axis of the wire, were tested in fields up to 22 and 31 kilogauss, the field being perpendicular to the axis of the wire, which was rotated about its axis to obtain different orientations. Values of $R_H/R_{0°C.}$ were measured for temperatures about 20° K. and 14° K., and by extrapolation from these the residual resistances of the two wires were determined. Curves were constructed showing the relations between $R_H/R_{0°C.}$ and H at the low temperatures employed. Considerable differences were found for the two crystals, which did not exist at higher temperatures. At 14° K. the relation between R_H and H proved to be exceedingly complicated; the point requires clearing up, but the effect seems to be a real one. H. N. A.

2906. Measurements with the Aid of Liquid Helium. Part VII. Transition to Superconductivity in Tantalum and Thorium. W. Meissner. *Zeits. f. Physik*, 61. 3–4. *pp.* 191–198, 1930.

Superconductivity was observed in three specimens of tantalum: of these, the purest specimen had the highest residual resistance at 4·5° Abs. The transition curve from residual resistance to superconductivity changes with the current density. In the case of thorium the transition takes place in a range of 0·2°, whereas with many superconductors the change occurs in the course of a few hundredths of a degree. The cause of the less steep curve in thorium is discussed. [See also Abstract 2623 (1930).]

G. E. A.

2907. Change of Resistance of Gold Crystals at Very Low Temperatures in a Magnetic Field and Superconductivity. P. Kapitza. *Roy. Soc., Proc.* 126. *pp.* 683–695, *March* 3, 1930. *Phys. Zeits.* 31. *pp.* 713–720, *August* 1, 1930.

In a recent paper Meissner and Scheffers [see Abstract 1554 (1930)] published measurements on the change of resistance of gold crystals in a magnetic field at low temperatures. They propose a formula which differs from that deduced from his investigations on a number of metals by the author. He shows, however, that the curves deduced from the two formulæ for this particular case differ very little indeed from one another at the temperature of liquid nitrogen, and that the experimental results of Meissner and Scheffers satisfy either of them equally well. Also discusses the values of $\Delta R/R_0$ obtained by Meissner and Scheffers at the temperature of liquid hydrogen, which come quite close to the author's curve. The additional and residual resistances are of the same magnitude, which agrees with the author's theory. The critical remarks of Meissner and Scheffer on the author's suggestion on the origin of superconductivity are answered. H. N. A.

2908. Double Sign of the Hall Effect. C. Bellia. *N. Cimento*, 8. *pp.* 91–98, *March*, 1930.

The electronic theory of electric conduction indicates, contrary to

experiment, a Hall effect of negative sign in all metals. The author seeks to explain the double sign of the effect by means of the hypothesis of the rotating electron which explains the anomalous Zeeman effect and other phenomena. Every electron is considered as having a motion of rotation by which it acquires a magnetic moment. On account of its rotation and its motion of translation across the molecule the electron must experience something analogous to the phenomenon of Magnus, that is, must be subject to a force normal to the axis of rotation and to the velocity of translation. In a metallic sheet placed in a magnetic field and traversed by a current, every electron must be subject to electric force, to electromagnetic action and to the Magnus effect. In the magnetic field the electrons having a magnetic moment are able to turn themselves parallel to the field or in the opposite direction; by quantum statistics may be calculated the number n_1 of those which set themselves parallel and the number n_2 of those which are orientated inversely, if $n_1 > n_2$. The constant R of the Hall effect is then deduced as consisting of two terms, a negative equal to that obtained from the ordinary electronic theory, and a positive due to the Magnus effect. According as one or the other term prevails the constant R will be negative or positive. J. J. S.

2909. Transport of Energy in Kathode Dark Space of Glow Discharge. I. Runge. *Zeits. f. Physik*, 61. 3–4. *pp.* 174–184, 1930.

The distribution of energy which is communicated to gas molecules by collision with ions, among molecules moving in different directions, has been calculated for a general case in which the possibility of several consecutive collisions is taken into account. The calculations have been corrected in order to allow for the increase of the energy of the ions between collisions due to the action of the field. Further, the energy lost by collisions with the kathode has been allowed for in cases of anomalous kathode fall for varying values of the thickness of the dark space. F. J. W.

2910. Velocities of Ions in the Kathode Dark Space. K. G. Emeléus. *Roy. Irish Acad., Proc.* 39*a*. 5. *pp.* 49–57, *March*, 1930.

A discussion is given of existing data bearing on the distribution of velocities of ions in the kathode dark space, with special reference to kathode falls of potential not much greater than " normal " values. The first section deals with the information to be obtained from positive rays. Subsequent sections are concerned with (1) the calculation of the distribution of velocities at the kathode for certain definite conditions of discharge; (2) the effect of the primary dark space and kathode glow; and (3) the phenomenon of sputtering. [See Abstract 3136 (1929).] A. W.

2911. Charging of Particles Suspended in the Corona Discharge. W. Deutsch. *Ann. d. Physik*, 4. 6. *pp.* 823–828, *March* 26, 1930.

Polemical against Schweitzer [see Abstract 2273 (1930)]. F. J. W.

2912. Space Charges and Electric Breakdown in Gases. W. O. Schumann. *Zeits. f. techn. Physik*, 11. 5. *pp.* 131–143, 1930.

A theoretical discussion is given of the influence of space charges on the Townsend discharge equations both for steadily applied potentials and for surge potentials. From the Townsend discharge conditions it is shown that while the electrons must traverse the whole path between the electrodes, the spacial distribution of the positive ionisation is not an essential factor as far as the neighbourhood of the kathode is concerned. The current consists almost entirely of electrons. The increase

of the current prior to breakdown as the potential is raised is next considered for different ionisations. The increase of current immediately before breakdown is then calculated, and, finally, an approximate calculation, based on Rogowski's theory, is made of the space charges for surge potentials. [See also Abstract 1266 (1929).] A. W.

2913. Absorption Coefficient for Slow Electrons in Cadmium and Zinc Vapours. R. B. Brode. *Phys. Rev.* 35. *pp.* 504–508, *March* 1, 1930.

The variation with the electron velocity of the absorption coefficient, α, or the effective collision cross-section has been measured in the vapours of cadmium and zinc and found to follow a curve of the type previously found for mercury. The cadmium curve has a maximum at about 40 volts, $\alpha = 130$, and a minimum at about 25 volts, $\alpha = 126$, followed by a steady rise with decreasing velocity to the limit of accurate measurements, 1 volt, $\alpha = 700$. The zinc curve has a very flat maximum at about 50 volts, $\alpha = 76$, a minimum at about 36 volts, $\alpha = 74$, followed by a steady rise to $\alpha = 500$ at 1 volt. The magnitudes of the maxima are in the order: Cd, $\alpha = 130$; Zn, $\alpha = 75$; and Hg, $\alpha = 60$. Other related properties of these atoms, such as the molar refractivity and the critical potentials, show this same irregularity in order. AUTHOR.

2914. Asymmetric Scattering of Doubly Reflected Electrons. E. Rupp. *Zeits. f. Physik*, 61. 3–4. *pp.* 158–169, 1930.

A further attempt has been made to detect the polarisation of electronic waves [see Abstract 2276 (1929)], using electrons of higher velocities. In these experiments electrons of 10, 40 and 80 kV have been twice reflected at gold surfaces at grazing incidence. The angle ϕ between the axis of the rays and the second reflector was varied and an asymmetric scattering of the electronic waves was detected for the 40 and 80 kV beams. The phenomenon was not observed for the 10 kV beam. The asymmetry can be expressed by the formula $R = A(1 - \delta^2 \cos\phi)$, where A and δ are constants [see Mott, Abstract 3254 (1929)]. δ increases with increasing electronic velocity. If beryllium is vaporised on to the gold surface the asymmetry disappears, but can be made to reappear by condensing a further layer of gold over the beryllium. The asymmetry is attributed to the polarisation of the electronic waves. F. J. W.

2915. Effect of Size of Diaphragm Openings on the Absolute Values Obtained for the Effective Sectional Area of Gases. O. Beeck. *Zeits. f. Physik*, 61. 3–4. *pp.* 251–262, 1930.

The diaphragm openings employed by Ramsauer and his colleagues were necessarily of finite area, and thus an unavoidable source of error was introduced, so that the true values of the effective sectional area are larger than those measured. The author has calculated the necessary corrections, and finds that the percentage correction increases with the effective sectional area. The correction for the actual dimensions of the apparatus employed diminishes at first slowly as the size of the openings is reduced, and could only be neglected for very small openings, with which, however, measurements would be impossible on account of the very small intensity which would result. H. N. A.

2916. Ionisation Potentials of CN and C_2 Molecules. H. Kallmann and B. Rosen. *Zeits. f. Physik*, 61. 5–6. *pp.* 332–337, 1930.

The selective absorption of ions is used to deduce the ionisation

potentials of chemically unknown molecules or molecules otherwise difficult to deal with. For CN and C_2 they obtain values of 14 and 12 volts. [See Abstract 2637 (1930)]. A. C. M.

2917. Grimm's Law and the Ionisation Potentials of Molecules of Water and Ammonia. R. Grinfeld. *Phys. Zeits.* 31. *pp.* 247–252, *March* 15, 1930.

The ionisation potentials of ammonia and water have been determined by Lenard's method to be $16 \cdot 1$ volts $\pm 0 \cdot 5$ and $18 \cdot 0$ volts $\pm 0 \cdot 5$ respectively. These values are in good agreement with those of neon and methane and therefore bring evidence in support of Grimm's law, which considers water, ammonia and methane as pseudo neon atoms. Using the Franck-Hertz method the excitation potentials of water are fixed at $6 \cdot 4$, $19 \cdot 6$ and $25 \cdot 5$ volts with perhaps two others at $14 \cdot 0$ and $20 \cdot 1$ volts. It is concluded that the resonance potential of water is $6 \cdot 4$ volts. F. J. W.

2918. Photoelectric Phenomenon in Solutions of Potassium Ferrocyanide. A. Blanc. *Comptes Rendus*, 190. *pp.* 674-676, *March* 17, 1930.

Relatively feeble light from a quart mercury-arc lamp falling on the surface of a solution of potassium ferrocyanide as kathode, with an anode 5 mm. above, produces a photoelectric current which is 300 times smaller than that from a freshly prepared surface of zinc under the same conditions. In the case of the solution, however, fatigue is quite negligible. The curve connecting photoelectric current and electrical field is of exactly the same type as for metals. The results of previous investigators on the effect of varying the concentration of the solution are vitiated by their failure to maintain a strictly constant field. For a given electrical field the photoelectric current varies in proportion to the weight of ferrocyanide contained in the same volume of solution. A. J. M.

2919. Enhancement of Photoelectric Action of Potassium by Hydrogen. R. Fleischer and H. Teichmann. *Zeits. f. Physik*, 61. 3–4. *pp.* 227–233, 1930.

The authors show that for the formation of a highly light-sensitive layer, especially with a selectivity at 4360 Å., the simultaneous presence of potassium vapour and molecular hydrogen is necessary. Suhrmann's supposition that positive H ions are necessary for the production of the selectivity of potassium is without foundation. E. E. F. d'A.

2920. Effect of End Losses on Characteristics of Filaments of Tungsten and other Materials. I. Langmuir, S. MacLane and Katharine B. Blodgett. *Phys. Rev.* 35. *pp.* 478–503, *March* 1, 1930.

The leads of a tungsten filament in vacuum cool the ends of the filament and so affect the voltage, candle-power, electron emission and other properties of the filament. For long filaments, where there is a central portion at a uniform temperature T_m, the temperature distribution near the lead is derived. A method for determining T_0, the temperature of the lead-filament junction, is given. Tables and formulæ are presented which allow ready calculation of the effect of the leads on the properties of any long tungsten filament for which the current and diameter are known. From the more general results it has been found that the decrease in voltage due to the cooling of one lead may be represented by

$$\Delta V = 0 \cdot 154(T_m/1000) - 0 \cdot 081(T_0/1000) - 2 \cdot 1 \,.\, 10^{-8}\, T_0 T_m - 0 \cdot 056.$$

There is an extension of the theory to cover the cases of filaments in gases, filaments of other materials, etc. Part II of the paper gives figures from which may be found the properties of filaments so short that the first theory does not apply. Some experimental checks of the theory are given. In general, the results and the methods of application have been placed first, and the mathematical derivations have been placed at the end of each part. For a short filament with leads cooled in liquid air a negative slope of the volt-ampere characteristic when the central temperature is much smaller than T_m is observed. AUTHORS.

2921. Thermionic Emission and Electrical Conductivity of Oxide Kathodes. A. L. Reimann and R. Murgoci. *Phil. Mag.* 9. *pp.* 440–464, *March*, 1930.

The following observations were made: The electrical conductivity c of a "formed" alkaline earth oxide varies with the temperature T according to a law of the form $c = \alpha\epsilon^{-\beta/T}$, where α and β are constants. During the process of forming, both the thermionic emission and the conductivity grow similarly, and after its completion both are "poisoned" similarly by exposure of the oxide to (*a*) oxygen, (*b*) a discharge in carbon monoxide, and (*c*) a discharge in hydrogen. Complete recovery of the formed condition by re-forming is possible only a few times in succession after poisonings by (*a*) and (*b*), but any number of times after poisoning by (*c*). At current densities comparable with those in the coatings of oxide kathodes from which saturated thermionic space current is being taken, the current conducted through an oxide powder between two electrodes, embedded therein, also saturates. On the basis of these observations the authors form a theory of the action of an oxide kathode, involving the supposition that the coating conducts the space current, which passes through it electrolytically. E. E. F. d'A.

2922. Anode Rays of Sodium, Potassium, Calcium and Barium. A. Poirot. *Comptes Rendus*, 190. *pp.* 735–736, *March* 24, 1930.

Using the method previously described [see Abstract 311 (1930)] and the nitrates of the metals concerned, with a current of about 0·5 mA, stable and long-continued emission of anode rays of sodium, potassium, calcium and barium has been obtained, the duration of which depends on the metal, varying from 3 to 10 hours. Addition of any other salt is a positive disadvantage. The voltage in the tube varies from a few hundred volts for sodium to several thousand volts for barium. From the colour of the discharge it appears that the atoms carry only a single charge. The spectrograms show, in addition to the metal under examination, only hydrogen rays and a band spectrum due to the lubricant, and these only faintly. C. A. S.

2923. Electric Oscillations in Coils and Wires. E. Hallén. *Uppsala Univ. Årsskrift*, 1. [102 *pp.*], 1930.

An important contribution to the mathematical theory of oscillations in coils and wires, using the integral equation method as in Oseen's work. A. W.

2924. Interaction of Electric Charges. A. S. Eddington. *Roy. Soc., Proc.* 126. *pp.* 696–728, *March* 3, 1930.

A sequel to two previous papers on the subject [see Abstracts 1064 and 1613 (1929)]. In Part II the analogies of classical dynamics were appealed to, and the value 136 was found for $hc/2\pi e^2$. This had in view 136 sym-

metrical degrees of freedom, a generalisation of rotations and translations in space. It is characteristic, however, of a pair of electrons that they possess one special degree of freedom, which has no analogue in the theory of a single electron, an alteration of the distance between them. The 136 rotations are relative to the frame of reference, the odd degree of freedom represents alteration of an absolute quantity, the interval. The distinction between time and space is now traced down to the transformation properties of matrices of Dirac's type. It seems likely that, when a number of electric charges form a rigid system, 1/137 of their mass is lost; this should give an approximate value for the packing fraction in atomic nuclei, and is, in fact, intermediate between the loss of mass in He and in O. The problem is worked out by means of wave mechanics, using the special relativity theory, and an equation is arrived at for two electrons with interaction, the space of the first electron being taken as standard, and the second electron being " put into the space of the first." H. N. A.

2925. Theory of Ferromagnetism. F. Bloch. *Zeits. f. Physik*, 61. 3–4. *pp.* 206–219, 1930.

The eigenfunctions of zero approximation, and the eigenvalues of the first approximation, for the term systems of higher multiplicity are determined for the exchange process of electrons in a crystal. The coupling between spin and orbit is neglected. This makes it possible to investigate the ferromagnetic behaviour at low temperatures, and in particular to decide what are the conditions under which ferromagnetism becomes possible. It appears that this is only the case with a space lattice. The saturating magnetisation has for low temperatures the form $M(T) = M(O)[1 - (T/\Theta)^{3/2}]$ where Θ is approximately the same as the Curie point T_c, M(O) is the saturating magnetisation at absolute zero. In its general character the $T^{3/2}$ law appears to correspond with the results of observation. The method differs from that of Heisenberg, which appears to be very troublesome when accurate results are required. H. N. A.

APPARATUS AND INSTRUMENTS.

2926. Moll's Vibration Galvanometer for Alternating Currents. S. L. Straneo. *N. Cimento*, 7. *pp.* 99–116, *March*, 1930. *Accad. Lincei, Atti*, 11. *pp.* 472–477, *March* 2, 1930.

The mode of action is studied of Moll's oscillation galvanometer derived from the ordinary vibration galvanometers for a.c. by means of the addition of a small mirror fixed asymmetrically on the vibrating cord. The addition of the little mirror causes the transversal vibrations of the cord to be associated with torsional vibrations, which may be read by reflection, and vibrations in a plane normal to the plane of vibration of the cord itself, deprived of Moll's arrangement. Yet, considering in practice only very small torsional vibrations, it appears that even after the application of the mirror the vibrations of the cord may still proceed in the original plane. A short description is given of a systematic model in which the mode of action of the galvanometer may be seen much amplified. J. J. S.

2927. Vibration Galvanometer with Improved Evenness of Response. W. Meissner and U. Adelsberger. *Zeits. f. techn. Physik*, 11. 4. *pp.* 102–107, *and* 11. 5. *pp.* 143–147, 1930.

The principle of the method is to add a condenser in the galvanometer circuit, so that the capacity, together with the self-inductance of the

galvanometer itself, gives a tuned circuit with a resonance curve having a peak at some frequency ω_1. The galvanometer has its own mechanical frequency ω_2, and by suitable design the response of the instrument may be made practically independent of frequency in the range ω_1 to ω_2. The theory is set out fully, and the constructional details of an instrument actually made are given. A number of curves are reproduced showing the degree of flatness of the resonance curves, and also dealing with the sensitivity. The latter is not inferior to existing types of vibration galvanometers. By inserting additional inductance in series and in parallel with the galvanometer, the sensitivity may be further increased, without any serious restriction of the range over which response is independent of frequency. J. H. A.

2928. New Low-Resistance Galvanometer with Short Period. A. Deubner. *Zeits. f. techn. Physik*, 11. 5. *pp.* 163–165, 1930.

The galvanometer consists essentially of a loop of aluminium wire suspended in a strong magnetic field produced between the specially-shaped pole-pieces of a chrome steel magnet. One pole has a recess and the other a tongue fitting into this recess and producing a gap in which the movement is suspended. The loop is examined through a microscope, or the instrument can be used as an oscillograph. The galvanometer has a resistance of 5–10 ohms, and can be made for a sensitivity of $5 \cdot 10^{-8}$ amp. per mm. under an 80-times magnification. The natural period is of the order 0·2 sec. G. E. B.

2929. Theory of the Duanten Electrometer. K. Engel. *Ann. d. Physik*, 4. 5. *pp.* 575–606, *March* 10, 1930.

This mathematical and experimental paper contains a discussion of Hoffmann's comprehensive theory of the Duanten electrometer [see Abstracts 549 (1914) and 1308 (1917)], for the purpose of ascertaining the effect of certain simplifications upon the complex formulæ derived by Hoffmann. The theoretical section considers non-symmetry in the electrometer, sensitivity for large angles, air-damping and fluctuation phenomena (Brownian movement). The practical sections deal comprehensively with the methods of measurement and with instrumental technique. The paper should be consulted in its entirety. H. H. Ho

2930. Coordinate A.C. Potentiometer in Circuits of Small Power. D. C. Gall. *Journ. Sci. Instruments*, 7. *pp.* 103–104, *March*, 1930.

The power required from the source for the operation of the Gall a.c. potentiometer [see Abstract 1663 (1923)] is about 12 watts and is too much for the usual types of valve oscillators. The author describes a valve supply unit, made by H. Tinsley & Co., which can be used in conjunction with his a.c. potentiometer. W. C. S. P.

2931. Self-Balancing Potentiometer. F. Moore. *Rev. Sci. Instruments*, 1. *pp.* 125–139, *March*, 1930.

After a brief survey of earlier kinds of electrical and mechanical type instruments the author describes the Wilson-Maeulen potentiometer recorder. It differs from other instruments of the mechanical type in that no lever associated with the mechanism for changing the relative position of the slide wire and its contact is given rotational movement while in engagement with the galvanometer arm. This is fully described and illustrated. Particulars of various parts of the mechanism and the

materials from which they are constructed are given, such as the release arms, roller-ratchet mechanism, sensing fingers, etc. The interchangeable galvanometers of these self-balancing recorders can be easily removed and replaced, and when the case is locked the adjustments of standardisation cannot be tampered with. The two rheostats are independent of each other, one being for standardising the slide-wire circuit and the other the automatic electric cold-junction compensator, which is energised from a separate battery. By means of elongated perforations perfect chart feed has been acquired to allow for humidity. T. C. H.

2932. Temperature Compensation and Adjustment of Magnetic Variometers. H. E. McComb and A. K. Ludy. *Terr. Mag.* 35. *pp.* 29–34, *March*, 1930.

A horizontal-intensity magnetic variometer was equipped with a quartz-filament suspension, the tips of which were bent at right angles before attachment to the supports. The instrument was compensated for temperature, and the effectiveness of this compensation checked in a short time by determination of base-lines when the instrument was operated at different temperatures. AUTHORS.

2933. Determination of the Constants, in Particular the Capacity of Radiation Apparatus. W. Kolhörster. *Phys. Zeits.* 31. *pp.* 280–284, *March* 15, 1930.

Working with an ionisation chamber with electrometer built in, the determination of the rate of production of ions depends on the effective volume, and the capacity of the electrometer system. The correction to the effective volume to allow for " dead corners " and the reduction of the correction by suitable design of the reading microscope tube and other structures projecting into the chamber are discussed. For the determination of the capacity of the electrometer system (about 0·5 cm.), the following methods are described: (*a*) a preparation of U_3O_8, the α-ray ionisation of which is known, is placed in the chamber and the electrometer discharge rate measured; (*b*) a suitable source of γ-rays is employed and the discharge rate determined, (1) with the electrometer isolated, (2) with the electrometer connected to a known cylindrical capacity by means of the charging rod, (3) as (2), but with a different cylindrical condenser; (*c*) a charge sharing method leading to the determination of a capacity of the order 3 cm. to which known methods can be applied. Method (*a*) gives the capacity without possible error due to the discharging rod, but there is a danger of contaminating the chamber. Method (*b*) gives usually too high values. Numerical examples and comparisons of the different methods are given, and it is concluded that the constants of radiation apparatus are determinable and reproducible with an accuracy of 1 %. [See also following Abstract.] W. S. S.

2934. Capacity Determination of Radiation Apparatus. V. F. Hess and A. Reitz. *Phys. Zeits.* 31. *pp.* 284–288, *March* 15, 1930.

An elaborated form of the second method described by Kolhörster [see preceding Abstract] is described. The modification consists in effect in using the charging rod itself as an additional capacity, an independent determination giving the total capacity of electrometer system plus charging rod. For instruments with small charging-rod capacity, the method gives values the deviations of which from the mean amount to about 1 %. W. S. S.

2935. Measurement of Small D.C. Potentials and Currents in High Resistance Circuits with Triode Valves. W. B. Nottingham. *Frank. Inst., J.* 209. *pp.* 287–348, *March*, 1930.

A complete survey of the application of thermionic valves to potential measurements, mainly from the mathematical point of view. General relations are discussed, and also the effects of small quantities of residual gas, etc. The arrangements cover deflection, null and bridge methods, and among matters investigated are sensitivity, stability, etc. G. E. B.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

2936. Law of Neuro-Muscular Excitation by Short Electric Discharges in Man. P. Fabre. *Comptes Rendus*, 190. *pp.* 449–451, *Feb.* 17, *and pp.* 595–597, *March* 3, 1930.

Experience has shown that the limiting quantity of charge necessary to provoke neuro-muscular action is independent of the time of the discharge. The author has investigated the effects of condenser discharges, and his apparatus is illustrated. The observations are complicated by: (1) the inclusion of the resistance of the subject's body; (2) by the capacity relative to the earth of the instruments and the subject; (3) by the variation in resistance of the skin of the subject; (4) by displacements of the electrodes used relative to motor points. The author is of opinion that variations from the general law of neuro-muscular excitation, as based upon the kinetic theory, are apparent rather than real when regard is taken of the causes of variation. In a second paper dealing with the effect of h.f. discharges on the biceps muscle contraction it is found that the law of excitability is modified by the discharge of the cell membranes. The effect is to prolong the discharge and hence to modify the normal law of excitation, but, in the case of sustained h.f. discharges, the effect of the positive wave is exactly neutralised by that of the negative wave, whereas with damped discharges, it is the first wave which has the greatest influence, and this is greater the greater the damping. If the damping is exaggerated the excitation effect is modified by the retention of the charge by the membranes. B. J. L.

2937. Recent Work in Electro-Biology. M. A. Schirmann. *E.u.M.* 48. *pp.* 269–271, *March* 23, 1930.

Discusses the problems of electro-biology, referring to the work of Keller and Pringsheim and, particularly the work of Fürth [see Abstract 2023 (1930)] whose methods of investigation are discussed in detail. B. J. L.

2938. Spectral Emission of Quartz Mercury-Vapour Lamps. A. Andant and J. Lecomte. *J. de Physique et le Radium*, 1. *pp.* 65–76, *Feb.*, 1930.

Detailed particulars are given of investigations carried out by means of a spectrographic thermocouple apparatus to measure the emission of mercury-vapour lamps of five different constructions, which are illustrated. It was found that (1) for the same arc the radiation varies greatly with the applied potential; (2) with different arcs, for any particular wave-lengths, the variation of emission for a given change of conditions of operation differs according to the particular type of arc, *i.e.* the emission is dependent upon burner construction. B. J. L.

2939. Light Sensitisation. A. Eidinow. *Brit. J. of Radiology*, 3. *pp.* 112–127, *March*, 1930.

Raabs in 1900 showed that fluorescent dyes sensitised living organisms to the visible light rays. Later observers have found other photodynamic

agents. Photodynamic action is dismissed on general grounds, and whereas oxygen is necessary for the induction of a reaction in the visible light region, this is unnecessary in the ultra-violet region. The action is comparable to chemical catalysis. Reducing agents inhibit the action of sensitisers. The author's experiments have shown that the resulting action is dependent on volume and concentration of the irradiated fluid, concentration of the sensitiser, and intensity of the radiation particularly with respect to distance and to temperature. Experiments are described regarding the action upon bacteria and unicellular organisms *in vitreo*. Different spectral regions show maximum effect with various sensitisers. Whereas a lethal effect upon human parasites can be obtained *in vitreo*, to obtain a like result *in vivo* would result in a similar lethal effect upon the sensitised subject. Blood serum has a protective effect upon the hæmolysis of blood cells, although these are affected by sensitisers in serum free-washed corpuscles. Enzymes, toxins and antitoxins are destroyed by light in the presence of sensitisers. Fluorescence and luminescence are then discussed with respect to the necessary presence of impurities, etc., and fluorescent or secondary radiations may be used as exciting agents for sensitisation. Experiments upon animals in relation to sensitisation are then described in detail, and the effect of light on the bactericidal power of the blood is discussed at length in relation to therapeutic results (with eosin, erythrosin and fluorescin) with suitable dosage and to toxic effects with excessive dosage. A Bibliography of the work of investigators in this field is appended. B. J. L.

2940. Electric Field of the Human Body. W. E. Boyd. *Brit. J. of Radiology*, 3. *pp.* 128–135, *March*, 1930.

The electrical variations which accompany muscle and nerve phenomena are of an ionic nature. In the electrocardiograph the phenomenon is complicated by other currents due to polarisation or skin currents. To avoid these effects a.c. is preferably used. It is impossible to have kinetic electrical phenomena without accompanying static phenomena, and static changes are modified by extraneous effects, as the presence of live plug sockets in the room, etc. The author, to study static effects, has constructed a laboratory which is really a large Faraday cage. This is described, and the recording instruments are described in detail and consist of an Einthoven galvanometer with valve amplification. Friction of the body and clothes gives rise to charges, and to avoid these the subject is clothed in a copper thread suit. It is shown that the skin of the body alters in static potential with the heart-beats, but the potentials corresponding with the P and T curves of the electrocardiograph have not yet been discovered. All parts of the skin have a potential relative to other parts of the skin and earth, and there are periodic variations of potential originating internal to the skin. The human body is surrounded by a varying field of static origin and variations must result by the approach of persons to each other. Work of a similar nature by Sauerbruch and Schumann [see Abstract 1994 (1928)] is referred to and the possible importance of work of this nature upon our conceptions of disease. B. J. L.

2941. Improved Model of Portable Electroscope for Hospitals. G. W. Spicer. *Brit. J. of Radiology*, 3. *pp.* 138–140, *March*, 1930.

A portable electroscope for the purpose of discovering radium needles and applicators when lost during hospital procedure is described in detail and illustrated. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

2942. Adsorption of Water by Wood. L. M. Pidgeon and O. Maass. *Am. Chem. Soc., J.* 52. *pp.* 1053–1069, *March,* 1930.

It is observed that variation in the amount of adsorbed water in wood has a definite effect on many of its physical properties such as swelling, strength, etc. A method is described whereby the adsorption of water by various samples of coniferous woods and pure cellulose can be examined throughout the complete range of vapour pressures and between temperatures of 12° to 42° C. The adsorption isothermals are of interest in connection with modern theory of gel structure. Results are given for green wood and for wood dried in the open for at least one year. The values obtained for pure cotton cellulose are lower than for wood. The results obtained for the adsorption of benzene are also given. The form of the adsorption curve shows that wood may be classed as a swelling gel. Surface adsorption governs the first part of the curve. The rest of the curve is due to the filling up of the submicroscopic spaces. J. K.

2943. Sorption of Gases on Crystal Surfaces. J. B. M. Herbert. *Faraday Soc., Trans.* 26. *pp.* 118–127, *March,* 1930.

The rates of sorption of ammonia on sapphire and of ammonia and sulphur dioxide on sodium chloride have been measured at 0° C., and over a range of pressure of approximately 10 to 760 mm. The system ammonia-sodium chloride gives results which show that at low pressures and during the initial stages of the sorption at high pressures, the logarithm of the amount sorbed is a linear function of the logarithm of the time. From a rough estimation of the area of the sorbent, it is calculated that the highest sorption recorded is equivalent to a layer of ammonia about seven molecules thick if the sorption corresponds with true surface adsorption. The results obtained for the systems sulphur dioxide-sodium chloride, and ammonia-sapphire satisfied a linear relationship between the logarithms of the amount sorbed and the time over the whole of the experimental range investigated. In no experiment (although they were prolonged for as much as three months) was a sufficiently close approach to saturation obtained for extrapolation to the equilibrium value to be possible. F. J. W.

2944. Adsorption of Gases by Solids. A. Ganguli. *J. Phys. Chem.* 34. *pp.* 665–668, *March,* 1930.

A review of the work of Kar and the author on this subject. F. J. W.

2945. Theory of Electrical Adsorption. K. C. Kar and A. Ganguli. *Zeits. f. Physik,* 61. 5–6. *pp.* 411–415, 1930.

The adsorption of ions from solution at an interface is considered theoretically. It is suggested that there is no essential difference between electrical and chemical adsorption. It is assumed that the adsorption of the ions occurs independently of one another and that in the case of both positive and negative ions both electrical and chemical adsorption take place simultaneously, although for a given ion either electrical or chemical adsorption predominates. From these assumptions a formula is developed which gives the relation between the concentration of the ions and the amounts adsorbed. F. J. W.

2946. Vapour Pressures of Solutions and the Ramsay-Young Rule. Application to the Complete System Water-Ammonia. F. C. Kracek. *J. Phys. Chem.* 34. *pp.* 499–521, *March*, 1930.

A systematic method for the treatment of vapour-pressure data on solutions by the Ramsay-Young rule is developed, and is applied in detail to the complete system of aqueous ammonia solutions over the whole range of compositions, and for vapour pressures up to 10,000 mm. of mercury. The vapour-pressure curve for saturated solutions is calculated from data on unsaturated solutions and the melting-point curve. Thermodynamic expressions for the heat of vaporisation in terms of the Ramsay-Young rule are worked out for solutions and applied to solutions of water and ammonia at 25° C. A. J. M.

2947. New Method of Determining the Distribution Curve of Poly-Disperse Colloidal Systems. C. E. Marshall. *Roy. Soc., Proc.* 126. *pp.* 427–439, *Feb.* 3, 1930.

The various methods of applying the centrifuge to the quantitative mechanical analysis of continuously poly-disperse systems are reviewed and shown to be, at best, highly inconvenient, laborious and inaccurate. In consequence a new method of using the high-speed laboratory centrifuge has been worked out in detail and shown to be applicable within the range 2μ — 20 mμ, whilst its accuracy is capable of considerable variation to suit different needs. Under conditions suited to clays, the accuracy is reliable to about 1 %, which is comparable with the accuracy of existing methods for fractions greater than 2μ. The variations in the degree of dispersion of bentonite under different conditions have been investigated as an example of the application of the new method to clay problems.

H. H. Ho.

2948. Use of Monometallic Electrodes with Dissimilar Surfaces in Investigating the Formation of Colloidal Systems. Part I. Formation of Ferric Hydroxide Hydrosol. A. Dumanski and T. Granskaja. *Kolloid Zeits.* 50. *pp.* 116–124, *Feb.*, 1930.

The effect of chemical polarisation at dissimilar monometallic electrodes is applied to the study of the transformation of ferric ions into colloidal particles of ferric hydroxide. Characteristic S-shaped titration curves are observed, and it is found that the maximum slope of such curves corresponds with the equivalence point of electrometric titration. T. H. P.

2949. Thixotropy of Iron-Oxide Sols. W. Heller. *Kolloid Zeits.* 50. *pp.* 125–130, *Feb.*, 1930.

Some gels appear to undergo the reversible thixotropic transformation sol-gel (by shaking) at suitable concentration in the absence, and some only in the presence, of other substances (salts or metal) [see Freundlich, Abstract 1695 (1929)]. The attractive forces between the particles vary with the constellations of the particles and with the concentrations of the disperse phase and the electrolyte. Experiments with iron-oxide sols, dialysed to different degrees, show that any process which destroys the sol may produce thixotropy. As the coagulating tendency decreases, the quantity of electrolyte necessary for recongelations becomes very small, and the gels become clearer and more transparent. Instable sols congeal in the course of time to thixolabile jellies. When in sols, of insufficient disperse-phase concentration but sufficient electrolyte concentration, thixotropy is no longer possible, a peculiar rhythmic folded struc-

ture develops in the bottom jellies, circular constrictions appearing in successive horizontal layers. H. B.

2950. Determination of Charge on a Colloid and Mechanism of its Coagulation. M. N. Chakravarti, S. Ghosh and N. R. Dhar. *J. Phys. Chem.* 34. *pp.* 326–334, *Feb.*, 1930.

The origin of electric charge on colloid particles is due to the preferential adsorption of ions from an electrolyte present in the medium. The counterparts of the adsorbed ions form a double layer and surround the colloid particles. The thickness of the double layer is now found to be at least of the order 10^{-7} cm. and not 10^{-8} cm., as is supposed by Lamb, whilst the electric charge on a colloid particle cannot be more than 10^{-6} e.s.u. It has been shown that all the ions from a coagulating electrolyte are not effective in coagulation, and an explanation is given why a threshold value of electrolyte concentration must be attained. The precipitation values of ions of different valencies are found to be: $N_1 : N_2 : N_3 \ldots = 1 : \frac{1}{2}\alpha : \frac{1}{3}\alpha^2 \ldots$, where $\alpha = e^{-\frac{qe\int Dr}{kT}}$, when coagulating ions are not adsorbed by the colloid due to residual affinity, or do not adsorb similarly charged ions or are not very different in their ionic mobilities. Valency is the main factor in determining the coagulating power of an ion. Coagulation occurs when the electrical density reaches a certain minimum value beyond which agglomeration is very rapid. The value of this minimum electrical density depends upon the interfacial tension of the colloid particles. The belief that hydrophile colloids are very stable towards electrolytes because of their high solvation is found to be invalid. Stability sometimes depends on lower interfacial tension. H. H. Ho.

2951. Swelling Pressure and Osmotic Pressure. H. Hulshof. *K. Akad. Amsterdam, Proc.* 33. 2. *pp.* 165–175, 1930.

A discussion of the forces operating at the contact of a liquid with a solid wall; of the thermodynamic potential at the boundary layer; of the mechanism of swelling or imbibition; of osmotic and swelling pressures, which are considered to be the same, osmotically active particles being swelling centres in a solvent; the relations of Perrin's particles and diffusion to swelling. T. H. P.

2952. Testing of Monocrystalline Wires. W. J. de Haas and P. M. van Alphen. *K. Akad. Amsterdam, Proc.* 33. 2. *pp.* 128–129, 1930. *In English. Comm. No.* 204*d from the Phys. Lab., Leiden.*

A method is described for fixing the direction of the crystal axis and testing the monocrystallicity of wires of 0·2 mm. diameter and less, to which Bridgman's method cannot be applied. The wire is traversed by a fine beam of continuous spectrum ("white") X-rays, which falls on a photographic plate, forming Laue spots, the position of which depends on the orientation of the crystalline axis in the wire. The wire with the photographic plate behind it can be moved, either step by step or continuously, so that the X-ray beam falls on new portions of the wire. In one case a series of Laue spots are photographed which lie on straight lines parallel with the wire, if the wire is a monocrystal; in the other the spots fuse into straight lines parallel to the wire. Even a slight twist in the wire alters the appearance of these lines, which are no longer straight. H. N. A.

2953. Crystals of Tungsten Deposited on Tungsten. T. Fujiwara. *Kyoto Coll. Sci., Mem.* 13. *pp.* 149–161, *March*, 1930. *In English.*

Microphotographic and X-ray (Laue) studies of the crystals which are

deposited on mother crystals of tungsten, single or multiple, by the method of Alterthum [see Abstract 2620 (1924)]. A crystal of tungsten is heated by the electric current in an atmosphere of hydrogen and steam; some metal is carried away from the hotter portion as WO_3 and is redeposited as metal on the colder portion. The mother crystal is first etched electrolytically. The crystals are hexagonal prisms or rhombic dodecahedrons, the former frequently imperfect and lamellar. There are also granular growths and clusters of larger microcrystals, mostly in random orientation, but sometimes in regular arrangement. When the mother crystal is a single prismatic crystal, the deposited crystals have the same crystallographic form, and the individual crystals deposited grow in the definite direction of the extended lattice structure. H. B.

2954. Preparation of Bismuth Monocrystals. L. Schubnikow. *K. Akad. Amsterdam, Proc.* 33. 3. *pp.* 327–331, 1930. *Comm. No.* 207*b from the Phys. Inst. Leiden.*

The crystals were grown in a narrow trough, which had the form of the rod required; it was built up of plates of quartz or steatite, resting on a long plate of nickeled copper, which was heated at one end, and the trough was covered by a plate of quartz or steatite. A small rod formed of a bismuth monocrystal was brought into contact with the liquid bismuth at one end of the trough; it served as a bud crystal from which crystallisation of the liquid proceeded as the copper plate cooled down. The bud crystal was held in an adjustable holder, so that it could be orientated in such a way that the crystal would grow in the trough with its axes in the direction required. It is easy to obtain monocrystals with the principal axis of the crystal perpendicular to the length of the rod, more difficult with the axis parallel to the length of the rod, it is then difficult to avoid twinning. [See also Abstract 2338 (1930).] H. N. A.

2955. Lattice Parameters of Gold-Silver Alloys. G. Sachs and J. Weerts. *Zeits. f. Physik,* 60. 7–8. *pp.* 481–490, 1930.

Accurate measurements of the lattice parameters of gold-silver alloys have been carried out. Details are given of the experimental method. It is found that the lattice parameters do not follow the law of mixtures, the values obtained experimentally being invariably less than the law predicts. A minimum is found for alloys containing 30 % (atomic) of silver. F. J. W.

2956. Behaviour of Single Crystals of α-Iron and α-Brass over the Region of Brittleness. F. Sauerwald, B. Schmidt and H. Dienenthal. *Zeits. f. Physik,* 61. 3–4. *pp.* 153–157, 1930.

The brittleness of α-iron at the temperature of liquid air is shown to be a consequence of the tendency of the crystal to split along the crystal planes. Single crystals of α-brass are not brittle over the region of brittleness at 600° C. Slipping only occurred along the octahedral planes. The brittleness of α-brass is, therefore, due to the specific action of the grain boundaries. F. J. W.

2957. Transition Temperatures of Cobalt and Nickel. Oxides of Nickel. S. B. Hendricks, M. E. Jefferson and J. F. Shultz. *Zeits. f. Krist.* 73. 3–4. *pp.* 376–380, *March,* 1930. *In English.*

Cobalt undergoes two structural transformations. The hexagonal close-packed structure is stable below 400° C. ± 20°, at which temperature a transformation to a cubic close-packed lattice occurs. This reverts

to a hexagonal close-packed structure at 1015° C. ± 20°. Cobalt cast from the melt does not pass through the intermediate cubic form on rapid cooling, but the high-temperature hexagonal structure is maintained through an unstable region until it again becomes the more stable phase. The magnetic inversions of cobalt and nickel are not accompanied by structural transformations. In cobalt obtained by reduction of Co_3O_4 at temperatures below 400° C., the reflection due to the plane (101) is abnormally diffuse. The dissociation pressure of Ni_2O_3 is probably greater than 100 atmospheres at 300° C., and the method described by Clark, Asbury and Wick for the preparation of Ni_2O_3 in fact yields only NiO.

A. J. M.

2958. Behaviour of Vanadium and Vanadium-Iron Alloys towards Hydrogen. L. Kirschfeld and A. Sieverts. *Zeits. f. Elektrochem.* 36. *pp.* 123–129, *March*, 1930.

The absorption of hydrogen by vanadium increases in extent with the purity of the metal, increase in the proportion of oxygen in the metal being accompanied by a proportional decrease in the hydrogen absorbed. The absorption increases rapidly as the temperature falls from 400° C. to the ordinary temperature, at which the highest value obtained is 148·5 c.c. of the gas per 1 gramme of the metal. Both the volume and the atomic ratios agree closely with those for the system palladium-hydrogen. No pyrophoric products, such as Roscoe described, were obtained. Isothermal absorption at 400°, 600° and 800° C. gives rectilinear curves for $m = k\sqrt{p}$, but the curve for 300° deviates considerably from a straight line and indicates that at lower temperatures, if the absorption were large enough, the isotherms would have a portion parallel to the pressure axis. With three vanadium-iron alloys, the isotherms at 900° and 700°, the curves connecting the volume of hydrogen absorbed with $\sqrt{p}$ are rectilinear; the isobars correspond with the characters of the two component metals. The absorption at atmospheric pressure is at all temperatures far below the additive absorption. [See also Abstract 2028 (1930).] T. H. P.

2959. Passivity of Metals. Part IV. Influence of Acids in Passivity and Corrosion. U. R. Evans. *Chem. Soc., J. pp.* 478–492, *March*, 1930.

The corrosion of iron in various acid solutions was investigated. The strong oxidising and weak base dissolving power of chromic acid is found to produce passivity when present alone, but to stimulate corrosion if sulphuric acid is present as well. Anodic passivity in acid solution is explained on the lines of the protection of the metal surface by products of the reactions bringing about the passivity. The corrosion is considered to be due for the most part to sulphur dioxide or hydrogen chloride, and carbon dioxide was not a dangerous corrosive agent for iron. [See also Abstract 1637 (1930).] F. J. B.

2960. Cadmium as Protection against Corrosion. A. Siemens. *Zeits. f. Elektrochem.* 36. *pp.* 101–105, *Feb.*, 1930.

The development, advantages and technology of cadmium as a protective coating. Cadmium is generally deposited electrolytically from solutions of the complex potassium cyanide salt, containing about 40 gm. cadmium per litre, with a small addition of a colloid. The current efficiency is high, and as only a thin coating is necessary the process is short. The solution has good throwing power and gives deposits superior, as regards

non-porosity, to zinc and nickel. Cadmium has a higher solution potential than iron, and a layer 5μ thick gives protection equal to that of a zinc coating 12–13μ thick, or a nickel coating of 25μ. A harder coating is obtained by heating, after plating, to 200° C. for some hours, to bring about further alloying with the iron, or by depositing chromium or nickel on the cadmium. Cadmium can be deposited directly on most metals, but with aluminium a preliminary thin coating of copper is necessary. Alloys of cadmium are deposited from double cyanide solutions. An extensive Bibliography is given. A. J. M.

2961. Passive State and Adhesion. Millicent Nottage. *Roy. Soc., Proc.* 126. *pp.* 630–631, *March* 3, 1930.

A copper plate boiled in absolute alcohol, and plunged while still hot into water containing a few drops of nitric acid, was found to be in the passive state, and some adhesion experiments were made between it and steel and copper (normal) cylinders, using palmitic acid as lubricant. The adhesion was considerably increased as compared with normal copper, and though no experiments were made with passive copper on passive copper, the value of the adhesion between them can be calculated as 21,000 gm. per sq. cm.; the value for steel on steel is 15,860, and for copper on copper 14,200 (both normal). The values denote a remarkable increase in the intensity of the attraction field produced by a surface film (probably of oxide) of extreme tenacity. H. N. A.

2962. Optimum Concentration of Phosphorogen and Flux in Zinc Sulphide and its Variation with the Temperature of Preparation. R. Coustal and F. Prevet. *Comptes Rendus*, 190. *pp.* 739–741, *March* 24, 1930.

In the preparation of phosphorescent zinc sulphide at 800–1400° C. by the calcination method and at about 3000° C. by the explosion method [see Abstract 2624 (1929)] with copper as phosphorogen, the optimum percentages of (1) flux (a mixture of alkali salts) and (2) copper, and (3) the optimum duration of heating diminish greatly as the temperature used rises. Thus, at 800° C. these magnitudes are (1) over 2, (2) 10^{-4}, (3) 2 hours; at 1200° C. (1) 1, (2) $0{\cdot}7 \cdot 10^{-4}$, (3) 20 minutes; at 1400° C. (1) $0{\cdot}1$, (2) $0{\cdot}3 \cdot 10^{-4}$, (3) 5 minutes; at 3000° C. (1) 0, (2) not more than 10^{-6}, (3) a few seconds. When manganese is used as phosphorogen, such diminution of its optimum concentration (10 times that required with copper) with rise of temperature is not observed. T. H. P.

2963. Laws of Combustion of Colloidal Powders. H. Muraour and G. Aunis. *Comptes Rendus*, 190. *pp.* 485–488, *Feb.* 24, 1930.

Previous results regarding the total area $\int p dt$ of the pressure-time curve combined with the formula $V = a + bp$ [see *Bull. Soc. chim.* 41. p. 1451, 1927)] imply that this area should diminish considerably for low densities of loading. This is confirmed by experiments carried out with a powder free from solvent and containing 13 % N, in a bomb of 150 cc. capacity, giving pressures of from 54 to 4310 kg./cm.^{2}, from which K [the value of $\int p dt$ corrected for variations at the beginning and end of the p–t curve; see *Bull. Soc. chim.*, 39. p. 841, (1926)] is calculated. Defining the *vivacité* as 1/K, this is shown to be a linear function of the inverse of the maximum pressure (save for the lowest pressure—54 kg./cm.^{2}). The *vivacité* for a pressure of 70 kg./cm.^{2} is about double, and, therefore, the value of $\int p dt$ about half what these respectively are for a pressure of about 2000 kg./cm.^{2} C. A. S.

2964. Inflammation and Combustion of Carbon Disulphide. M. Prettre and P. Laffitte. *Comptes Rendus*, 190. *pp.* 796–798, *March* 31, 1930.

The earlier work on this subject [see Abstract 3431 (1929)] has been extended. It is found that the temperature of inflammation is a linear function of the proportion of CS_2 in the mixture, over the range of the experiments. Further, the temperature is uninfluenced by the addition of slight traces of water vapour or considerable quantities of CO_2. Methane has a slight effect. After all experiments a small amount of a brown solid was left on the walls of the combustion tube. Analysis of this solid showed that it had the empirical formula CS. F. J. W.

2965. X-Ray Studies of Cellulose Derivatives. Relation between Acetylcellulose I and Acetylcellulose II and Conversion of Cellulose Hydrate into Natural Cellulose. K. Hess, C. Trogus, W. Osswald and K. Dziengel. *Zeits. f. phys. Chem.* 7. *Abt. B.* 1. *pp.* 1–17, *March*, 1930.

Acetylcellulose I and acetylcellulose II are reversibly interconvertible; the position of the equilibrium depends upon the temperature and the nature of the solvent in which the equilibrium is set up. Acetylcellulose I corresponds with natural cellulose and acetylcellulose II with cellulose hydrate. In consequence of the reversible equilibrium between the two acetates the two forms of cellulose become reversibly interconvertible through the medium of the acetates. The position of the cellulose equilibrium will be dependent upon the position of the acetate equilibrium. [See following Abstract.] F. J. W.

2966. X-Ray Studies of Cellulose Derivatives. Lattice Changes in Nitrocellulose. C. Trogus, K. Hess and J. R. Katz. *Zeits. f. phys. Chem.* 7. *Abt. B.* 1. *pp.* 17–24, *March*, 1930.

Nitrocellulose in the fibre state undergoes characteristic lattice changes on treatment with organic liquids. These changes are reversible and are analogous to those which occur with acetylcellulose. [See preceding Abstract.] F. J. W.

2967. X-Ray Investigation of the Structure of Copper-Zinc Oxide Catalysts. R. H. Aborn and R. L. Davidson. *J. Phys. Chem.* 34. *pp.* 522–537, *March*, 1930.

Methanol vapour is passed over a catalyst consisting of mixed oxides of copper and zinc at 360° C., and the effect of variations in the initial proportions of the two oxides on the crystal structure of the catalyst and the yield of methyl formate, formaldehyde and carbon monoxide is observed. In all cases the structure of the catalyst after the action is of the same lattice type as the final principal components (copper and zinc oxide) in their normal states. With increasing proportions of zinc oxide in the catalyst the length of the elementary cube of the copper lattice increases, probably due to the formation of α-brass. The unit cell of zinc oxide contracts when the zinc oxide concentration is high, and expands with high copper concentration, but the axial ratio remains constant. These changes may be due to a partial reduction of the oxide or to solid solution of copper in the oxide. No diffraction lines from free zinc are observed, but γ-brass may occur. With pure copper oxide as catalyst, methyl formate and formaldehyde are the primary products, while pure zinc oxide yields principally carbon monoxide. Using the mixed oxides there is an

important relation between interatomic spacings in the catalyst and its specific property of favouring a given reaction, though changes in lattice dimensions of the catalyst components do not seriously affect the amount of methanol decomposed. A. J. M.

2968. Synthesis of Nitrogen Dioxide in the Glow Discharge. J. W. Westhaver and A. K. Brewer. *J. Phys. Chem.* 34. *pp.* 554–562, *March*, 1930.

The results obtained in this work are very similar to those described earlier in the papers on the synthesis of ammonia [see Abstract 2359 (1930)]. In this case, however, the work has had to be limited to the synthesis in the negative glow, owing to the formation of ozone in the positive column. The rate of the reaction is independent, for a constant discharge current, of the pressure over as wide a range as could be investigated. The rate of reaction is directly proportional to the discharge current. A maximum yield of about one molecule of nitrogen dioxide was obtained per electron flowing in the outer circuit. The rate of reaction is a maximum in gas mixtures containing about 40 % oxygen. Helium has no effect on the rate below concentrations of 70 %: argon has a pronounced retarding effect. As for the ammonia synthesis, the reaction appears to be initiated by the N_2^+ ions. The possible mechanisms of the subsequent reaction between N_2^+ ions and oxygen are discussed, but the experimental data available do not permit any definite conclusions to be drawn. F. J. W.

2969. Work of Dissociation of Oxygen and of Sulphur. V. Kondratjew. *Zeits. f. phys. Chem.* 7. *Abt. B.* 1. *pp.* 70–73, *March*, 1930.

By means of data from optical methods detailed in the paper, the work of dissociation of O_2 and S_2 molecules has been determined as 120 and 101 kcal. respectively. H. H. Ho.

2970. Vapour-Pressure Measurements of Sodium and Determination of its Chemical Constant. R. Ladenburg and E. Thiele. *Zeits. f. phys. Chem.* 7. *Abt. B.* 3. *pp.* 161–187, *March*, 1930.

The paper commences with a survey of the earlier data concerning the chemical constant of sodium, following which new vapour pressure measurements are described made by a sensitive flow method with vacuum-distilled sodium between 614° and 771° Abs., to an accuracy of 1 to 2 %. The data are well represented by the formulæ: $\log (p.T^{1\cdot52}) = -\frac{26{,}400}{4\cdot573}\cdot\frac{1}{T} + 12\cdot439$, and $\log (p.T^{1\cdot178}) = -\frac{26{,}167}{4\cdot573}\cdot\frac{1}{T} + 11\cdot396$. The partial pressure of the sodium atom between 496° and 771° Abs. is represented by:

$$\log p_{Na} = -\frac{26{,}077}{4\cdot573}\cdot\frac{1}{T} - 1\cdot178\log T + 11\cdot329.$$

It is shown from the optical vapour-pressure measurements of the magneto-rotations of the D-lines that the apparent vapour pressure is proportional to the true value. The heat of evaporation of the sodium atom at absolute zero is $l_0 = 26{,}000 \pm 130$ cal. and the chemical constant is $i = 0\cdot78 \pm 0\cdot10$. H. H. Ho.

2971. Chemical Affinity and the Principles of Symmetry. A. Kapustinsky. *Zeits. f. phys. Chem.* 8. *Abt. B.* 1-2. *pp.* 72–80, 1930.

From the geometrical constructions of compact systems of spheres,

the dependence has been investigated of the symmetric constants upon the number of spheres. In order to compare similar systems with coordination bonds, the active zones of the atomic forces have been regarded as spheres, and on this conception the tendency to compactness corresponds to a minimum condition of potential energy. In this way the approximate connection between symmetry and stability has been found, and these deductions have been confirmed by examples in both inorganic and organic chemistry. H. H. Ho.

2972. Development of Colour by Photochemical Change in Concentrated Solutions of Ammonium Thiocyanate. B. S. Sharma. *Chem. Soc., J. pp.* 308–309, *Feb.*, 1930.

Experiments made in view of the conflicting views expressed as to the cause of this phenomenon show that traces of iron present are responsible for the coloration, that catalytic action of the iron plays no part, and that the iron actually participates in the formation of the compound, light supplying the necessary energy. The formation of ferric thiocyanate is doubtful, since this is decolorised neither by heating nor by keeping in the dark, and is bleached by light and entirely extracted by ether to give a solution leaving a coloured residue on evaporation; the extract from the insulated solution behaves otherwise. The compound in question appears to be a loose additive complex of ferrous thiocyanate and oxygen.

T. H. P.

2973. Photochemical Formation of Phosgene. S. Lenher and G. K. Rollefson. *Am. Chem. Soc., J.* 52. *pp.* 500–506, *Feb.*, 1930.

In this paper a mechanism has been proposed for the photochemical formation of phosgene at room-temperature involving COCl as an intermediate step. This mechanism has been compared with one previously proposed by Bodenstein, Lenher and Wagner [see Abstract 392 (1930)], involving COCl in a side reaction, and the assumptions involved in the two mechanisms are discussed. A possible mechanism for the reaction above 300° is suggested. H. H. Ho.

2974. Photolysis of Diazo-Compounds. W. Schröter. *Zeits. f. wiss. Phot.* 28. *pp.* 1–30, *March*, 1930.

Two methods have been employed and are now described for quantum measurements during the photolysis of diazo-compounds, *viz.*, the bleaching and nitrogen methods. By both methods, applied to the two substances, diazo-2:1-aminonaphtholsulphonic acid (I) and diazo-p-amidodiphenylamine (II), the quantum yield ϕ appears to be independent of changes of experimental conditions within wide limits such as: intensity and wave-length of the light, concentration and temperature of the solution. By the bleaching method $\phi(\mathrm{I}) = 0{\cdot}40 \pm 0{\cdot}06$ for $\lambda = 436$ $m\mu$, and $\phi(\mathrm{II}) = 0{\cdot}52 \pm 0{\cdot}05$. By the nitrogen method in aqueous solution, $\phi(\mathrm{I}) = 0{\cdot}35 \pm 0{\cdot}03$ and $\phi(\mathrm{II}) = 0{\cdot}20 \pm 0{\cdot}02$. Röntgen radiation produces no nitrogen from I, but effects an appreciable visible change. Acid addition leaves ϕ(I) almost unaltered, whilst ϕ(II) increases to 0·35. Alkali alters ϕ(I) to 0·15, but precipitates II from the solution as the sodium salt. The influence of non-aqueous solvents on ϕ is described, both methyl and ethyl alcohols producing an increase of ϕ. By the nitrogen method the photolysis of diazobenzene sulphonic acid and of its sodium salt gives $\phi = 0{\cdot}07$ to 0·1. The interpretation of these results is discussed.

H. H. Ho.

2975. Synthesis of Hydrogen Chloride by Light and α-Radiation. S. C. Lind and R. Livingston. *Am. Chem. Soc., J.* 52. *pp.* 593–608, *Feb.*, 1930.

The temperature coefficients of the synthesis of hydrogen chloride by light and α-rays have been determined by exposing precisely similar mixtures of hydrogen and chlorine to light and to α-radiation from radon at temperatures of 25° and 94° C. The coefficients for the photochemical (white light) and radiochemical syntheses are identical, but vary with the sensitivity of the mixture. The 10° value is 1·10 for an average chain-length of 2×10^3, rising to a constant value of about 1·20 for one of 8×10^4. There is some evidence that the coefficient is about 10 % higher for green light filtered through a saturated solution of nickel sulphate. Porter, Bardwell and Lind's results [see Abstract 822 (1927)] are confirmed so far as they show that, once started, the course of the reaction is independent of the starting agent, but not as regards their estimate (1 : 3·7) of the comparative yields per light quantum and per ion-pair, which are now shown to be approximately equal when monochromatic light ($\lambda = 2358$ Å.) is used, and not greatly different for white light. C. A. S.

2976. Present State of the Quantum Mechanics Theory of Homopolar Valency. W. Heitler. *Phys. Zeits.* 31. *pp.* 185–204, *March* 1, 1930.

The quantum mechanics theory of the interaction energy of two hydrogen atoms and the notion of "Austausch" energy are explained. A sketch of the symmetry properties of the Schrödinger equation, and of the group theory involved, leads to a general statement of the conditions for molecule formation between atoms containing n and m electrons respectively. In later sections the combination of excited atoms, polyatomic molecules, and the chemical and spectroscopic evidence in support of the theory are dealt with. A Bibliography of the principal papers on the subject is included. W. S. S.

2977. Temperature Measurements at Active Electrodes. Part III. B. Bružs. *Zeits. f. phys. Chem.* 146. *Abt. A.* 5. *pp.* 356–362, *March*, 1930.

The temperature effects at active electrodes are regarded as Peltier, *i.e.*, latent heat, effects of the electrode processes and their measurement enables the entropies of the ions to be determined. Data are given for silver, lead, cadmium, bismuth, zinc and copper electrodes, and general agreement with the theoretical values confirms the utility of the method for the entropy measurement of ions. For molar solutions of Ag^+, Pb^{++}, Bi^{+++} (nitrate) and Cd^{++}, Zn^{++}, Cu^{++} (sulphate) the following entropy data are given: 19, −1, −11, −26, −19, −29 (cal./deg.). [See also Abstract 2048 (1930).] H. H. Ho.

2978. Influence of Temperature on Polarisation Capacity and Resistance. E. E. Zimmerman. *Phys. Rev.* 35. *pp.* 543–553, *March* 1, 1930.

The temperature coefficient of polarisation capacity and resistance have been determined for gold and plain platinum electrodes in 0·63, 1·50 and 2·42 N solutions of sulphuric acid and also at different frequencies for 1·46 N concentration. To reduce the electrodes to a condition representing minimum capacity, a method of thermal treatment was employed and found quite effective. Values of the angle of phase difference have been computed

for the various conditions under which measurements were made. During the process of reducing the electrodes to a condition representing minimum capacity, the value of polarisation capacity decreased to about one-half the original value and the resistance increased to a few times the original value. The angle of phase difference increased 15 or 20°. After the electrodes were conditioned, consistent and reproducible values of capacity and resistance could be obtained. The temperature coefficient of capacity is about twice as great with platinum as with gold electrodes and is apparently independent of concentration. Phase difference changes only slightly with temperature, but increases with concentration. The absolute values of the slopes of the curves, capacity versus temperature and resistance versus temperature, decrease with increasing frequency. The temperature coefficient of capacity, however, increases with frequency for platinum electrodes and decreases in the case with gold electrodes.

AUTHOR.

2979. Electromotive Behaviour and Equilibrium Potential of Single Zinc Crystals. P. A. Anderson. *Am. Chem. Soc., J.* 52. *pp.* 1000–1008, *March,* 1930.

The electromotive characteristics of single metal crystals were determined with a view to obtaining data on the mechanism of electrode reactions and of metallic surface structure. Single zinc crystals were found to behave as reversible electrodes, the (0001) cleavage face measured in air-free cells of the type Zn, $ZnCl_2$ (0·5M), HgCl, Hg, yielded potential measurements constant to $\pm$ 0·02 mV and reproducible over dissimilarly prepared crystals to $\pm$ 0·1mV. The significance of the equilibrium potential was considered in the light of Kossel's calculation of the potential energy of atoms at various possible positions on a crystal surface. The potential was assigned to the " repeatable step " in the growth or disintegration of the crystal. F. J. B.

2980. Concentration Cells in Ethyl Alcohol: Mixtures of Sodium and Potassium Iodides. J. R. Partington and H. G. Simpson. *Faraday Soc., Trans.* 26. *pp.* 147–154, *March,* 1930.

Results are given of measurements of the e.m.f. at 25 $\pm$ 0·05° C. of the cells, Ag|AgI, NaI 0·1N|(NaI + KI)0·01 N, AgI|Ag and Ag|AgI, NaI 0·1N|(NaI + KI)0·02N, AgI|Ag, in ethyl alcoholic solution, the relative proportions of the sodium and potassium iodides in the mixture of constant total concentration being varied in different cases. It is shown that the isohydric principle does not hold in alcoholic solutions of the mixed iodides of total concentration 0·01N or 0·02N, and that the activity coefficient of sodium iodide in these solutions depends on the concentration of the potassium iodide present and not only on the total concentration of the mixture, as postulated by G. N. Lewis (*Thermodynamics,* p. 368, 1923). [See also Abstract 2027 (1929).] T. H. P.

2981. Electrometric Determination of the Two Dissociation Constants of Dibasic Acids. V. Sihvonen. *Zeits. f. Elektrochem.* 36. *pp.* 165–171, *March,* 1930.

A method of determining the two dissociation constants of dibasic acids is developed. The method depends upon the use of two half elements, one of which contains hydrochloric acid, the other the buffer solution, both of which are brought to the same ion normality by the addition of salts. Formulæ are obtained by the graphic extrapolation of the true thermo-

dynamic dissociation constants for the calculation of the negative exponent of the concentration constants and their dependence on the ionic strength. The heat of dissociation is calculated from the dissociation constants at 18° and 37° C. F. J. B.

2982. Measurement of Ion Adsorption by Silver Iodide by Means of Potentiometric Titration. E. Lange and R. Berger. *Zeits. f. Elektrochem.* 36. *pp.* 171–179, *March*, 1930.

The potentiometric titration of reactions involving precipitations was shown to be a useful means for determining the ion adsorption which brought about the change of potential. The formation of the electrochemical double layer was considered to be intimately connected with the capacity and the amount of the adsorbed ions. The systems AgI(solid)/$AgNO_3$ (solution), and AgI(solid)/NH_4I (solution) were investigated, and the results showed that a proportionality existed between the ionic adsorption and the change of potential. If the adsorbed ionic quantity is considered equal to the charge on the double layer a constant capacity of 60 mfd. was obtained for the double layer. F. J. B.

2983. Viscosity of Solutions of Electrolytes. B. N. Finkelstein. *Phys. Zeits.* 31. *pp.* 130–135, *Feb.* 1, 1930.

The theory developed by Einstein for the viscosity coefficients of solutions of non-electrolytes is generalised for the case in which the solute is a strong binary electrolyte and the solvent a dipole liquid, such as water. The formula arrived at is $\eta' = \eta\left[1 + 2{\cdot}5\phi\left(1 + \frac{25H^2}{84R^4} + \frac{1469H^4}{232848R^8}\right)\right]$, where η' and η are the viscosity coefficients of the solution and pure solvent respectively, ϕ is the volume assumed by the molecules of the solute in 1 c.c. of the solution, R is the semi-diameter of the dissolved particles and H is $\alpha\epsilon M/kT$, ϵ being the electric charge of the dissolved particle, k the Boltzmann constant, and T the absolute temperature. Quantitative accuracy of this expression is not expected, since various approximations have been made to facilitate calculation. T. H. P.

2984. Electrolytic Deposits on Aluminium and its Alloys. Ballay. *Comptes Rendus*, 190. *pp.* 305–308, *Feb.* 3, 1930.

When aluminium or one of its alloys is treated at 90° to 100° C. with a solution containing from 6 to 22 gm. of iron and 0·1 to 0·70 gm.-mols. of HCl per litre, it subsequently takes on an adherent nickel deposit formed from a hot bath and at high-current density. The nickel deposit may be readily chromium- or copper-plated. T. H. P.

2985. Electrolytic Reduction of Acid Solutions of Molybdenum. F. Foerster, E. Fricke and R. Hausswald. *Zeits. f. phys. Chem.* 146. *Abt. A.* 2. *pp.* 81–100, *and* 146. *Abt. A.* 3–4. *pp.* 177–231, *Feb.*, 1930.

The electromotive behaviour of solutions of Mo^{VI}/Mo^{V} and of Mo^{V}/Mo^{III} was investigated. The electrolytic reduction of $Mo^{VI} \rightarrow Mo^{V}$ and of $Mo^{V} \rightarrow Mo^{III}$ with kathodes of different unattacked materials was determined and compared in solutions containing hydrochloric and sulphuric acid. The reduction potential differed with the acid concentrations employed. It was shown that with electrodes of smooth gold and platinum the potential changes were greatly influenced by the polarisation, which depended upon the concentration of the solutions. The cause was ascribed to the formation of characteristic diaphragms on the kathode, the characteristics of which are subject to alteration. One peculiarity of the diaphragms is that

at a particular current density they do not reduce the current yield, but actually raise it, by reducing the current required to bring about the particular change. This forms the basis of a new point of view for electrolytic reduction changes. F. J. B.

2986. Electrolytic Preparation of Magnesium from Fused Fluorides containing Magnesium Oxide. G. Grube and H. Henne. *Zeits. f. Elektrochem.* 36. *pp.* 129–138, *March,* 1930.

In continuation of earlier experiments [see Abstract 2245 (1928)], results are given of the determination of the diagram for the ternary system, MgF_2 – NaF – CaF_2, and of experiments on the electrolytic separation of magnesium from fused mixtures of these fluorides in various proportions. T. H. P.

2987. Anomalous Anodic Behaviour of Palladium in Chloride Solutions. F. Müller and A. Riefkohl. *Zeits. f. Elektrochem.* 36. *pp.* 181–183, *March,* 1930.

To explain the anodic behaviour of palladium [see Abstract 1722 (1929)] it is supposed that: (1) Anodic polarisation of palladium in sodium chloride solution leads to the formation of palladous chloride, which is readily soluble in the solution, so that the metal remains active up to a critical current density. (2) If platinum forms an analogous compound, this must be difficultly soluble. (3) On anodic polarisation of palladium in nitrate or sulphate solution, assuming that palladous nitrate or sulphate is first formed, such compound or the oxide or hydroxide or basic compound formed therefrom is only sparingly soluble in the nitrate or sulphate solution. Attempts to verify these assumptions experimentally met with difficulties, but the results obtained are in qualitative agreement. T. H. P.

2988. Improved Form of Macro-Apparatus for Cataphoresis. F. O. Howitt and E. B. R. Prideaux. *Journ. Sci. Instruments,* 7. *pp.* 89–93, *March,* 1930.

A macro-apparatus for determining the velocity of electrophoresis by direct measurement of an interface made visible by a highly coloured sol is described. Whilst avoiding unnecessary complexity it embodies the main improvements suggested in the past for an apparatus of this type. The calibration of the instrument and an example of its use are given.

AUTHORS.

2989. Conductivity of Phiocyanates in Methyl Alcohol. Augusta Unmack, D. M. Murray-Rust and H. Hartley. *Roy. Soc., Proc.* 127. *pp.* 228–240, *April,* 1930.

The conductivity in methyl alcohol at 25° C. of solutions of the thiocyanates of six univalent and six di-valent kations has been measured over a range of concentration from 0·0001 *N* to 0·002 *N*. The results for the univalent kations, like those of Frazer and Hartley, are in good agreement with the Debye-Hückel-Onsager theory and indicate that in the series of the alkali metals the tendency to ionic association in dilute methyl alcohol solution increases with increasing atomic number. The mobility of the thiocyanate ion is found to be 60·9. [See also Abstract 418 (1926).]

AUTHORS.

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